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A SYSTEM FOR CLASSIFYING VEGETATION IN CALIFORNIA[1]

By Herbert A. Jensen[2]

Among the inventories needed for the management of our game resources are those concerned with vegetation cover. Because this cover involves many plant species and forms growing under a variety of climatic, soil, and moisture conditions while subjected to a wide range of treatment by man and beast, inventorying it usually introduces problems of classification. Many systems for classifying all or parts of this vegetation cover have been devised, but most of them have limitations preventing their general adoption. Most of them also have depended wholly upon ground observations.

While ground observations have many points in their favor and in some instances are indispensable, under certain conditions they are neither the most accurate nor the most economical means for classifying vegetation cover. Chief among the advantages of the ground technique is the ability to see such vegetation details as individual species and undergrowth. However, for area delineation the ground technique depends upon oblique or horizontal views in which the foreground-background factor produces erroneous impressions of both areas and vegetation composition. Thus many classification boundaries are determinable, if at all, only through considerable travel and search.

Aerial photos offer a technique that has many advantages over ground observations alone. This technique is especially useful when the vegetation classification is based upon specified proportions of the cover or ground occupied, when base maps are not of high quality or recent date, and when time and funds are limiting factors. On the essentially vertical views of aerial photos foreground-background differences are negligible, the various parts of the vegetation complex (excluding undergrowth) appear in their true proportions, and most boundaries are clearly evident. The addition of vegetation details (understory, etc.) by ground observation can then be made with a minimum of time and field travel by using the photo classification as the control. On the other hand, users of the photo technique should bear in mind that aerial photos are rarely maps on account of inherent characteristics that cause areas to appear in other than their true sizes and shapes. Chief among these characteristics are: (1) the variation in perspective from vertical at the center of the photos to a degree of obliqueness at their edges, and (2) the variation in distance between subject and camera lens that causes differences in scale whenever the ground is not level. But despite these characteristics the areas will appear in their true relationships to the terrain, and the size and shape distortions can be removed in the process of transferring the photo areas to maps.

[1] Submitted for publication June, 1947.

[2] California Forest and Range Experiment Station, United States Forest Service. The California Forest and Range Experiment Station is maintained at Berkeley in cooperation with the University of California.

Part of a classification system that has been designed to encompass all of California's natural vegetation without losing the character of its many transitional conditions, that is capable of flexible interpretation, and that is based upon the use of aerial photos [1] will be described here. Although not specifically developed for game management purposes, this classification system is as applicable to game management as it has proven to be in other fields. While the system has been designed for the use of aerial photos, it can also be applied to ground mapping if the photos are unavailable.

By themselves, the classifications presented may not furnish all the information needed for particular localities or projects. Their purpose is to provide, first, simple inventories that effectively stratify the vegetation complex into significant parts, and second, frameworks upon which subsequent intensifications by area, composition, or use can be added without duplicating previous efforts. These simple inventories serve not only the needs of most over-all surveys of large areas but also present a standard for discussions among game managers, foresters, range managers, watershed managers, and others concerned with the natural vegetation cover. The frameworks provide bases for finer breakdowns of areas (edge types, etc.) or species, or for an ecological classification such as that suggested by Graham (1945).[2] Such finer breakdowns also can be used in small blocks as detailed samples of the broader classifications, thereby reducing the amount of detailed work that would otherwise be necessary. Any detailed classification will be facilitated and more accurately located by having the broader classifications to use as a control.

These classifications and techniques of application are products of the California Forest and Range Experiment Station, a unit of the United States Forest Service. More specifically, they represent the joint efforts of several individuals under the leadership of A. E. Wieslander, Chief of the Division of Forest Economics. Their development can be followed through a number of articles and office manuals, the most pertinent of which are Wieslander (1935); Burks and Wilson (1939); Wieslander, Jensen, Wilson, and Burks (1942); Wieslander and Wilson (1942); and Forest Survey staff (1947). In its original form the system was used to inventory a considerable part of California and contiguous western Nevada, and maps of this work are available from the experiment station. The ground-mapping technique of that form became obsolete with the adoption of aerial photos prior to World War II. At the war's end the remainder of California was classified from photos, but only on a very extensive basis to provide certain forest statistics (Wieslander and Jensen, 1946). The over-all distribution of vegetation types, as then determined, by acreage (Table 1) and location (folded map), are reproduced here. The modernized form of the classification system is now an essential part of the station's state-wide timber inventory,[3] for which all commercial timberlands and intermingled areas are being classified

[1] In particular, those covering most of California—vertical photos of around three inches to the mile (1:20,000) scale, taken on panchromatic film with a minus-blue filter and an 8¼-inch lens. Photos that present greater detail than these would, of course, also be usable.

[2] A classification of the vegetation cover's ecological (successional) stages, as determined from a combination of pertinent vegetation and habitat factors.

[3] This project is one unit of the nation-wide forest survey being conducted by the United States Forest Service to ascertain and correlate data on the present supplies of timber and other forest products, growth and loss rates, present consumption, probable requirements, and other facts pertinent to balancing the Nation's timber budget.

down to a 40-acre minimum. In addition, it is a part of the intensification and extension of that inventory to be conducted by the State Division of Forestry on lands outside the national forests.

TABLE I

Areas of Vegetation Types in California

Type	Thousand acres	Percent
[illegible]	4,586	4.6
Redwood	1,788	1.8
Douglas-fir	2,289	2.3
Fir	1,757	1.7
Pine—Douglas-fir—Fir[1]	7,236	7.2
Spruce	[2]	
Lodgepole pine—Whitebark pine[3]	2,032	2.0
Pinon pine and Juniper	3,200	3.2
Minor conifers	405	.4
Woodland[4]	2,457	2.5
Woodland—Grass[5]	7,570	7.5
Chaparral	9,866	9.8
Coastal sagebrush	2,249	2.2
Great Basin sagebrush	5,071	5.1
Desert	24,276	24.2
Bushy herbs	[2]	
Grass	10,375	10.3
Marsh	79	.1
Barren	1,414	1.4
Cultivated and Urban—Industrial	13,704	13.7
Total land area	100,354	100.0

[1] Includes pine—Douglas-fir, Pine—Fir, Pine—Douglas-fir—Fir.
[2] Areas too small to be represented.
[3] Includes Lodgepole pine—Mountain hemlock, Whitebark pine—Foxtail pine.
[4] Includes dense stock of Woodland—Chaparral, Woodland—Sagebrush, where the hardwoods predominate.
[5] Includes open stock of Woodland—Chaparral, Woodland—Sagebrush.

Four sections of the system are presented here. The first concerns a basic photo classification of vegetation-cover and other land status elements; the second a vegetation species classification, which is not obtainable from the photos alone; the third a type classification; and the fourth a density classification. While the four together comprise a complementary group, the first can be considered either by itself or in any combination with one or more of the last three. A further classification, that of age classes of tree stands, is also a part of the system, but is not included in the present paper.

Section I. Classification of the Vegetation-cover and Other Land Status Elements

This is the basic classification. It segregates the natural vegetation complex into units that are generally identifiable on aerial photos and that have significantly different uses. Then, to provide for complete area coverage, certain other land-status elements are also included. With a field background in photo interpretation, the classification is wholly obtainable from the aerial photos now generally available. This classification is usable either by itself or as a framework upon which the other classifications can be added.

The Units Recognized

The elements of this classification, their definitions, and the symbols adopted to designate them are:

C—*Commercial conifers* (Fig. 64)[1]—Coniferous trees such as ponderosa pine,[2] redwood, Douglas-fir, white fir, lodgepole pine, and others that are considered of value for lumber, pulpwood, and related uses.

K—*Noncommercial conifers* (Fig. 65)—Coniferous trees such as whitebark pine, knobcone pine, piñon pines, bigcone-spruce, junipers, and others that are considered of little or no value for lumber, pulpwood, and related uses.

H—*Hardwoods* (Fig. 66)—Broadleaved trees such as oaks and madrone. Aspen and willows are also included.

S—*Chaparral* (Fig. 67)—Shrubs such as manzanitas, scrub oak, chamise, mountain-mahogany, and others that are mostly tall in stature and heavily branched.

T—*Sagebrush* (Fig. 68)—Shrubs such as the sagebrushes, bitterbrush, wild-buckwheats, and others that are mostly low in stature and slenderly branched, together with such taller associates as coyote brush and creosotebush.

F—*Bushy herbs* (Fig. 69)—Herbaceous plants such as ferns, Klamath weed, wooly mules-ears, and others that are bushy in size and character of growth.

G—*Grass* (Fig. 70)—Grasses, sedges, and other associated herbaceous plants that are not under cultivation.

M—*Marsh* (Fig. 71)—Areas of very poorly drained or partially submerged soils supporting herbaceous vegetation such as samphire, cattail, and others characteristic of those situations.

B—*Bare ground* (Fig. 72)—Areas of bare soil and litter-covered ground that are practically devoid of vegetation.

R—*Rock* (Fig. 73)—Lava, talus, cliff, boulders, and other rock conditions that are practically devoid of soil.

A—*Cultivated* (Fig. 74)—Lands that are being cultivated for farm crops, regularly-cropped natural haylands, irrigated pastures, and fallow fields.

U—*Urban—Industrial* (Fig. 75)—Residential, business, and industrial areas.

Classification Principles

On the ground the above elements are found either in single-element stands (Fig. 77), where no more than one element occurs in significant amount or, except for Cultivated and Urban—Industrial, in multi-element or mosaic stands (Fig. 78), where significant amounts of two or more occur intermixed. A mixture may contain any elements but it must be a true mixture, with the elements somewhat uniformly dispersed among one another (Figs. 78 and 80A), and not a patchy occurrence of differing groups of elements (Figs. 79 and 80B). Where the latter condition exists, proper treatment is the recognition of all distinct conditions and elimination of those from the inventory that are below the established minimum-area requirement. For example, the area in Figure 79 is in part hardwoods alone, in part grass alone, and in part chaparral alone or mixed with grass, not an over-all mixture of hardwoods, chaparral, and grass. The chaparral areas and one or more of the grass areas may be too small

[1] Although the aerial-photo technique is emphasized in this article, ground photos are used as illustrations because of the larger and more familiar views thus afforded. Figure 76 shows a few examples of the elements as they appear on 1:20,000-scale aerial photos. Since species and growth characteristics over the State vary, local preliminary ground comparisons and occasional subsequent checks are usually necessary for proper photo interpretation.

[2] The scientific names of all plants mentioned are listed in Table 3, at the end of this article.

to be included in the inventory. Similarly, the aerial view in Figure 80B shows a grass area with stringers, some very small, of hardwoods; not a grass-hardwood mixture such as is illustrated in Figure 80A. If the smaller areas are important to the inventory, provision for them should be made through lowered area-minimums or special designations.

Significant occurrence of the elements is specified in terms of the percentage of ground covered. Although the limits to be given have been arbitrarily established, experience has proven them both adequate to show real economic or ecological differences and practicable to observe under the techniques employed. Each element is considered separately. Commercial conifers are considered significant if they cover 5 percent or more of the ground. Other trees (noncommercial conifers and hardwoods) are likewise considered significant down to 5 percent when they are not in mixture with commercial conifers; but when so mixed their lower limit is 20 percent. For all other elements the lower limit is 20 percent. Figure 59 illustrates the densities represented by these limits. They are applied only to the portions of the elements exposed to the sky; those under the canopy of taller elements are inventoried by supplemental ground observations if wanted. Vegetation elements are judged on the basis of the space their crowns cover.

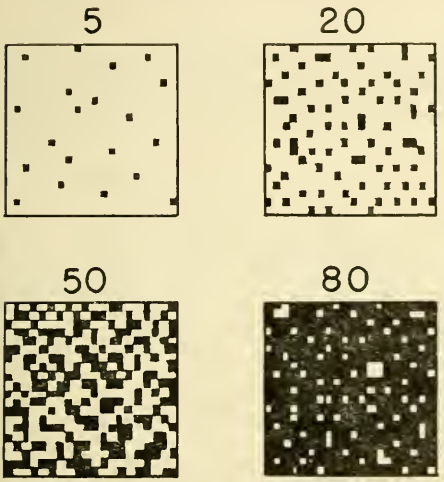


FIGURE 59. Diagramatic representation of the percentage limits used in the classifications. The four squares have, respectively, 5, 20, 50, and 80 percent of their areas blackened.

Limitation to the size of areas given recognition is also necessary if uniformity between workers is to be maintained. Individual vegetation - element areas will range from very large to very small, and somewhere between there is usually a size below which delineation is not profitable. The location of this limit will of course be determined by each particular job's requirements. For the State's intensification of the California Forest Survey referred to earlier, in which the inventory unit is the county, the minimum established is 10 acres for contrasting classes and 40 acres for noncontrasting classes. In general, the former involve changes in the presence of elements (e.g., GSH (Grass, Chaparral, Hardwoods), SG (Chaparral, Grass), HS (Hardwoods, Chaparral), C (Conifers)), while the latter involve changes in relative abundance among a constant group of elements (e.g., GSH, SGH, HSG).

Classifying Techniques

Depending upon the availability of suitable aerial photos and the experience and skills of the workers, the classification is adaptable to either aerial-photo or ground techniques. Reasons have already been given

why the former is better if it is supported by preliminary ground observations and occasional subsequent ground checks. Stereoscopic study of the photos will yield the maximum information, but is not always essential.

With either method the procedure simply requires observing the composition of the vegetation, drawing boundaries where changes occur, and entering appropriate designations in each delineated area to record its composition (Figs. 81-84). For example, the single-element stand illustrated in Figure 77 would be designated C and the multi-element stand in Figure 78 designated GSH. In the latter case the symbols are given the order that corresponds with the relative abundance of the elements on the ground. This record is made directly on the photo or map, whichever is being used as a base.

Judgment in estimating the percentage of ground covered by vegetation elements is developed and maintained through measurements along representative line transects or comparisons with such guides as appear in Figure 59.

Value of the Classification

The product of this classification will be an in-place record of the gross characteristics of the vegetation cover capable of use in either statistical or map (Fig. 60) form. The classification will be sufficient unto

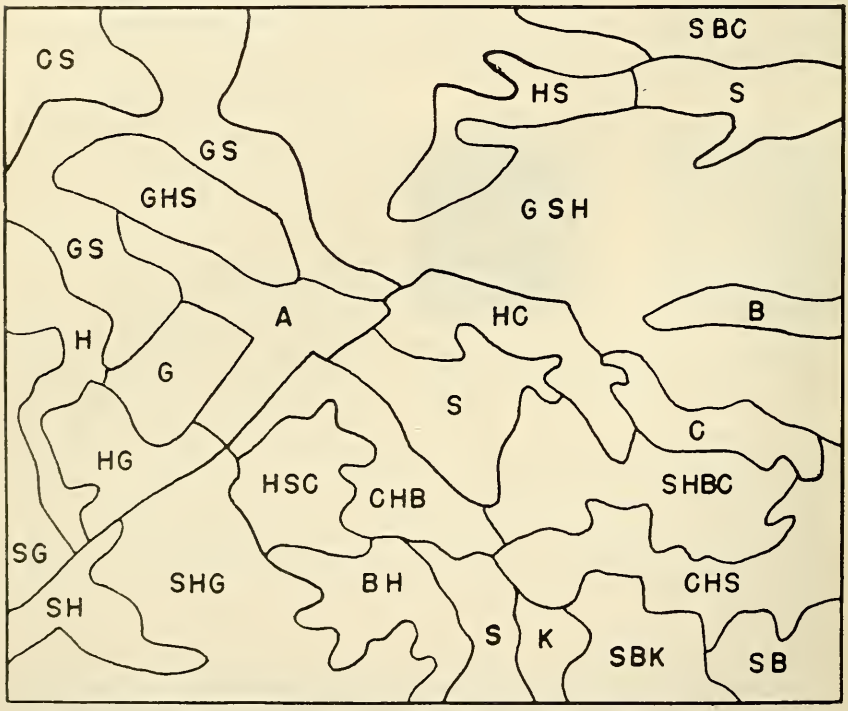


FIGURE 60. A sample map showing the classification of vegetation-cover and other land status elements. C = commercial conifers, K = noncommercial conifers, H = hardwoods, S = chaparral, G = grass, B = bare ground, A = cultivated.

itself as far as the features recorded provide the information needed. The acreage or location of grasslands segregated by their content of shrubs or trees might be cited as one example of information needed in game management. But more frequently this classification will find its greatest use in providing a flexible foundation for the remaining three sections, whose descriptions follow.

Section II. Classification of the Vegetation Species

This is a classification of the dominant-species composition of the vegetation elements recorded under Section I. Inasmuch as this involves the collection of information not generally recognizable on aerial photos, the data must be obtained by ground mapping. The vegetation-element boundaries are used as species-composition boundaries except where subdivisions are needed to bring out important differences.

The Units Recognized

The units of this classification are individual or groups of plant species. A list of California species, as prepared and used by the California Forest and Range Experiment Station in its state-wide Vegetation Type Survey, is presented with symbols to designate them in Table 4.* Figures 85-88 and some of the others that follow illustrate a few of these species.

Classification Principles

Like the vegetation elements, the species units will be found either in single-species stands (Fig. 85), where no more than one species occurs in significant amount, or in multi-species stands (Figs. 86-88), where significant amounts of two or more species occur intermixed. (What was previously stated about mixtures vs. patchy occurrence of the vegetation elements also applies here.) The single-species stands are usually regarded as "pure" stands and the multi-species stands as "mixed" stands, with the latter either simple mixtures (Fig. 86), where only one vegetation element is involved, or mosaic mixtures (Figs. 87-88), where two or more elements are involved.

Significance here is specified in terms of the percentage of crown cover occupied by individual species—determined separately for each vegetation element. Where only one element is present the percentage relates to the total cover, but where two or more are present each element constitutes a separate total against which its own component species are judged. For example, in the single-element stand of Figure 86 all species are considered with respect to the total cover, while in the multi-element stand of Figure 87 the individual sagebrush species are considered only with respect to the sagebrush cover and the commercial-conifer species with respect to the commercial-conifer cover. The lower limit of significance for species within each element recorded is 20 percent; again applying only to the vegetation exposed to the sky. Any species meeting this requirement is considered a dominant part of the complex. Where important species are present in less amounts special designation can be given to them within the framework of the standard classification.

* Since this list also includes those species most commonly found in game management inventories, the author consented to its inclusion in this paper.—*Ed.*

To take full advantage of the classification system each vegetation-element area delineated under Section I should be considered as a separate species-composition area, subject to boundary change only by subdivision within the established limits. In the state project previously mentioned the subdivision limit has been set at 40 acres (the same as that applied to noncontrasting vegetation-element classes). Thus in the state project, individual species-composition areas may go down to the 10-acre minimum of contrasting vegetation-element classes, where these have been delineated under Section I, but no vegetation-element area will be subdivided for species composition unless each resulting part exceeds 40 acres in size or involves an especially-significant species change over 10 acres in size.

Classifying Techniques

This classification is primarily a ground mapping operation inasmuch as the species units are seldom directly identifiable on the aerial photos now available. Some exceptions occur with very distinctive species or where the photography is of superlative character, but even then the bulk of the local species will be indistinguishable. On the other hand, considerable indirect help is obtainable from the photos. First, they provide control for the ground observation of species composition through the prior delineation of vegetation elements and second, they offer a means for expanding the species classification beyond what is actually seen on the ground through observable terrain and vegetational-association relationships visible both on the ground and from photos. Making full use of these aids cannot help but expedite and increase the accuracy of the species classification over what can be done by ground observations alone.

The procedure first involves determining the dominant-species composition of each vegetation-element area or its subdivisions and then recording that information by symbols on the aerial photos or maps. If aerial photos are not used, all of the areas must be viewed at close enough range that the species can be identified and their abundance estimated, at least with the aid of binoculars; if the photos are used, only a portion of the areas need be viewed directly. The boundaries drawn for the vegetation-element areas also serve for the species-composition areas. Only where subdivisions of the vegetation-element areas are justified will additional boundaries be drawn. When more than one dominant species occurs in an area, their relative abundance on the ground is indicated by the order in which the symbols are recorded. For example, the area represented by Figure 88, composed of vegetation elements GHSK, would be given species symbols B, V for element H, Cc for element S, and Dp for element K. Because of the inconspicuous variations in grassland composition, no species distinctions of the grass element are attempted. The areas represented by Figures 85 and 86, each composed of only one vegetation element, would be given species symbols Ci and Af, Api, respectively. The area in Figure 87, composed of two elements, would be given species symbols Atr, J.

Aids such as those suggested for the classification of vegetation elements will likewise be of help in the judgment of dominant-species composition.

Value of the Classification

This classification brings out differences between the vegetation elements that result from the unequal values of individual species. Knowing that an area has commercial conifers is useful information, but not as useful for many purposes as knowing whether the conifers are sugar pine or ponderosa pine, Douglas-fir or white fir, or mixtures of them. Not only are present stand differences then indicated but also the future developmental differences that would follow logging. Similarly, the information that the hardwood cover of an area is California black oak rather than Canyon live oak has more ecological value than just knowing that the area is covered with hardwoods. And among game management problems the distinctions between shrubs having different forage values (e.g., Figs. 85 and 86) may find important uses. Figure 61 gives the species classification of the same area that is in Figure 60.

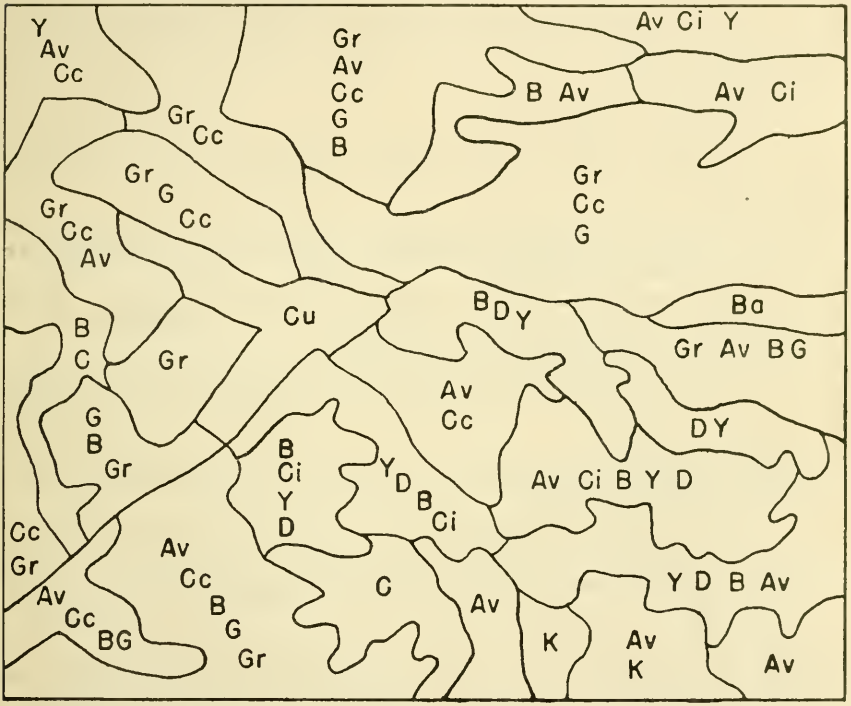


FIGURE 61. A sample map showing the classification of vegetation species for the same area as that in Figure 60. Av = White-leaf manzanita, B = California black oak, Ba = Barren, C = Canyon live oak, Cc = Wedgeleaf ceanothus, Ci = Deerbrush, Cu = Cultivated, D = Douglas-fir, G = Oregon white oak, Gr = Grass, K = Knobcone pine, Y = Ponderosa pine.

Section III. Classification of the Vegetation Types

This classification groups the vegetation-element areas (Section I) according to broad and specific use patterns. Considerable flexibility is possible within the framework of the basic vegetation-element classification. The specifications for any desired type classification may be quite restrictive (requiring complete similarity of elements for grouping), very

broad (requiring only the presence or absence of a single element for grouping), or something in between, depending upon the purpose for which they are made. Furthermore, varying sets of specifications can be established to permit study of the same area from different viewpoints. Except for any species identification that may be needed, this classification can be made entirely through office interpretation of the vegetation-element classification.

The Units Recognized

The set of specifications in use on the Forest Survey and Vegetation Type Survey of California is given below. It illustrates the possibilities of this type classification. With some combinations, the types listed correspond with those in Table 1.

(1) Vegetation Types That Contain Commercial Conifers:

Pine (Fig. 89)—Ponderosa, Jeffrey, or sugar pines (the timber pines) are dominants[1] of the commercial-conifer stand in the absence of redwood, Douglas-fir, or the true firs.

Redwood (Fig. 90)—Redwood is a dominant of the commercial-conifer stand, or giant sequoia is present.

Douglas-fir (Fig. 91)—Douglas-fir is a dominant of the commercial-conifer stand in the absence of ponderosa, Jeffrey, or sugar pines, singly or mixed, or redwood.

Fir (Fig. 92)—True firs (white or red) are dominants of the commercial-conifer stand in the absence of ponderosa, Jeffrey, or sugar pines, singly or mixed, redwood, or Douglas-fir.

Pine—Douglas-fir (Fig. 93)—Ponderosa, Jeffrey, and sugar pines, singly or mixed, and Douglas-fir are associated dominants of the commercial-conifer stand in the absence of redwood or the true firs.

Pine-Fir (Fig. 94)—Ponderosa, Jeffrey, and sugar pines, singly or mixed, and the true firs are associated dominants of the commercial-conifer stand in the absence of Douglas-fir.

Pine—Douglas-fir—Fir (Fig. 94)—Ponderosa, Jeffrey, and sugar pines, singly or mixed, Douglas-fir, and the true firs are associated dominants of the commercial-conifer stand.

Spruce (Fig. 95)—Sitka spruce is a dominant of the commercial-conifer stand in the absence of redwood, Douglas-fir, or the true firs.

Lodgepole pine—Mountain hemlock (Fig. 96)—Lodgepole pine, western white pine, and mountain hemlock are the only dominants of the commercial-conifer stand.

(2) Vegetation Types That Lack Commercial Conifers But Contain Noncommercial Conifers in Predominance Over Hardwoods:

Whitebark pine—Foxtail pine (Fig. 97)—Whitebark, foxtail, limber, or bristlecone pines are dominants of the noncommercial-conifer stand.

Piñon pine (Fig. 98)—Piñon pines are dominants of the noncommercial-conifer stand.

Juniper (Fig. 99)—Junipers are dominants of the noncommercial-conifer stand in the absence of piñon pines.

Minor conifers (Fig. 100)—Knobcone, Monterey, Bishop, Coulter, Torrey, or digger pines, bigcone-spruce, bristlecone fir, or cypresses are the only dominants of the noncommercial-conifer stand.

[1] For definition of a dominant, see Classification principles of Classification of the Vegetation Species, page 205. In the following type specifications, reference is made only to key species. Others, not key species, may also be present in any of the types.

(3) Vegetation Types That Lack Commercial Conifers But Contain Hardwoods in Predominance Over Noncommercial Conifers:

Woodland (Fig. 101)—Hardwoods not associated with chaparral, sagebrush, or herbaceous elements.

Woodland—Chaparral (Fig. 102)—Hardwoods associated with chaparral and the chaparral is more abundant than any sagebrush or herbaceous elements present.

Woodland—Sagebrush (Fig. 103)—Hardwoods associated with sagebrush and the sagebrush is more abundant than any chaparral or herbaceous elements present.

Woodland—Grass (Fig. 104)—Hardwoods associated with herbaceous (other than marsh) elements and the herbaceous elements are more abundant than any chaparral or sagebrush elements present.

Significant subdivisions of the above four Woodland types on the basis of species composition are:

Tanoak—Madrone (Fig. 105)—Tanoak, madrone, or California-laurel are dominants of the hardwood stand.

Black oak—Oregon white oak (Fig. 106)—California black or Oregon white oaks are dominants of the hardwood stand in the absence of Tanoak—Madrone species.

Live oaks (Fig. 107)—Interior, coast, or canyon live oaks are the only dominants of the hardwood stand.

Blue oak—California white oak (Fig. 108)—California blue, California white, or evergreen white oaks are dominants of the hardwood stand in the absence of Black oak—Oregon white oak and Aspen—Cottonwood species. Digger pine is a very common associate of this type.

Alder (Fig. 109)—Red or white alders are the only dominants of the hardwood stand.

Aspen—Cottonwood (Fig. 110)—Aspen, cottonwoods, willows, and California sycamore are dominants of the hardwood stand.

(4) Vegetation Types That Lack Trees:

Chaparral (Figs. 111 and 112)—Chaparral is the predominant vegetation element. Two subdivisions based on species composition are generally significant: (Fig. 111) where species other than chamise are most abundant, and (Fig. 112) where chamise is the most abundant chaparral species.

Coastal sagebrush (Fig. 113)—Sagebrush is the predominant vegetation element and the sagebrush species consist of California sagebrush, wild buckwheats, coyote brush, and others of similar distribution.

Great Basin sagebrush (Fig. 114)—Sagebrush is the predominant vegetation element and the sagebrush species consist of big sagebrush, bitterbrush, and others of similar distribution.

*Desert** (Fig. 115)—Sagebrush, including creosotebush, is the predominant vegetation element and the sagebrush species are those characteristic of the Mojave and Colorado Deserts. (Joshua-tree and interior barren areas are also included.)

Bushy herbs (Fig. 116)—Bushy herbs is the predominant vegetation element.

Grass (Fig. 117)—Grass is the predominant vegetation element.

*Marsh** (Fig. 118)—Marsh is one of the predominant elements present.

* As pointed out by the author, the types given here were established for the Vegetation Type Survey of the California Forest and Range Experiment Station. As further pointed out, it is recognized that these types will not necessarily meet all the needs of other workers. For example, game management workers will find it necessary to set up subdivisions of the broad desert and marsh types—*Ed.*

(5) Other Land-Status Types:

Barren (Fig. 119)—Bare ground and rock, singly or mixed, are the only elements present.

Cultivated (Fig. 120)—Cultivated is the only element present.

Urban—Industrial (Fig. 120)—Urban—Industrial is the only element present.

Classification Principles

Inasmuch as the basic data come from the classification of vegetation elements (Section I), the principles that apply there consequently become parts of this classification. If any supplemental species data, such as are

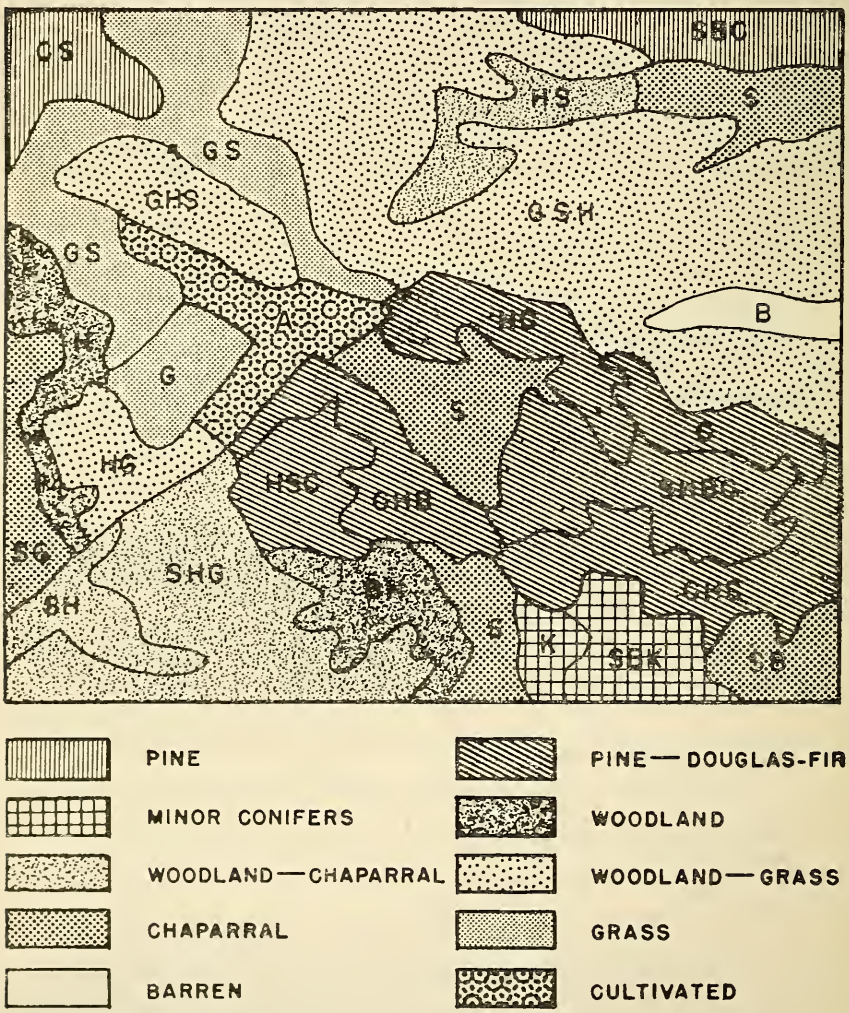


Figure 62. A sample map showing the classification of vegetation types for the same area as that in Figures 60 and 61

in the foregoing scheme, are also required, then the principles controlling the species classification likewise become applicable here.

One additional point of note is that as the classes are broadened so will the range of variation within each class increase and the distinction of transition conditions decrease. A compromise between the minimum of classes and maximum of distinctiveness is therefore to be desired.

Classifying Techniques

This classification is essentially an office translation of the record made under Section I, although the set of specifications given above also requires some ground observations. The office phase requires only a redesignation, by either symbols or colors, of the vegetation-element areas in accordance with the type specifications. Where species are the determining factor the types can be obtained directly from the species classification (Section II) if that has been made; otherwise through the procedure outlined for the species classification. But in either case retention of the basic vegetation-element classification will provide the means for better understanding of what the types include. Figure 62 shows the type classification given above superimposed on the area also covered by Figures 60 and 61.

The most useful way to present such a classification as this is to indicate the types by colors. A suggested color legend that brings out both relationships and contrasts, and that has been widely used in California is as follows:

Green— Commercial conifer types containing redwood or timber pines; the color shades or patterns decreasing in density through Redwood, Pine—Douglas-fir—Fir, Pine—Fir, Pine—Douglas-fir, and Pine.

Blue— Commercial conifer types lacking redwood or timber pines; the color shades or patterns decreasing in density through Douglas-fir, Fir, Spruce, and Lodgepole pine—Mountain hemlock.

Violet— Noncommercial conifer types; the color shades or patterns decreasing in density through Minor conifers, Piñon pine, Juniper, and Whitebark pine—Foxtail pine.

Red—Orange— Hardwoods types; the color shades or patterns decreasing in density through Woodland, Woodland — Chaparral, Woodland — Sage, and Woodland—Grass.

Brown— Shrub types (except Desert); the color shades or patterns decreasing in density through Chaparral, Coastal sagebrush, and Great Basin sagebrush.

Yellow— Herbaceous types; the color shades or patterns decreasing in density from Bushy herbs to Grass.

Black— Barren and Desert, with the color shades or patterns decreasing in that order.

Pink— Urban—Industrial and Cultivated, with the color shades or patterns decreasing in that order.

Standard map designation—Marsh.

Value of the Classification

This classification finds its chief value by summarizing the multitudinous vegetation details for particular purposes. Through groupings, specifically desired characteristics are placed in a form that is easily seen,

and characteristics not required are subordinated. As examples: The desired information may be the acreage or location of timber stands, livestock grazing areas, wildlife food crops, watershed cover conditions, or inflammability classes. While the classification presented will bring out these features, any of the specifications can be changed if the needs require.

Section IV. Classification of the Tree and Shrub Densities

This classification segregates the woody vegetation (the tree and shrub cover) according to its density. Two schemes are presented: (1) a separate photo classification made independently and concurrently with the vegetation-element classification (Section I), and (2) a close approach to the first, but obtainable by direct interpretation of the vegetation-element classification. Both schemes are applicable either to the tree and shrub cover as a whole, to any of its elements alone, or to any combination of its elements.

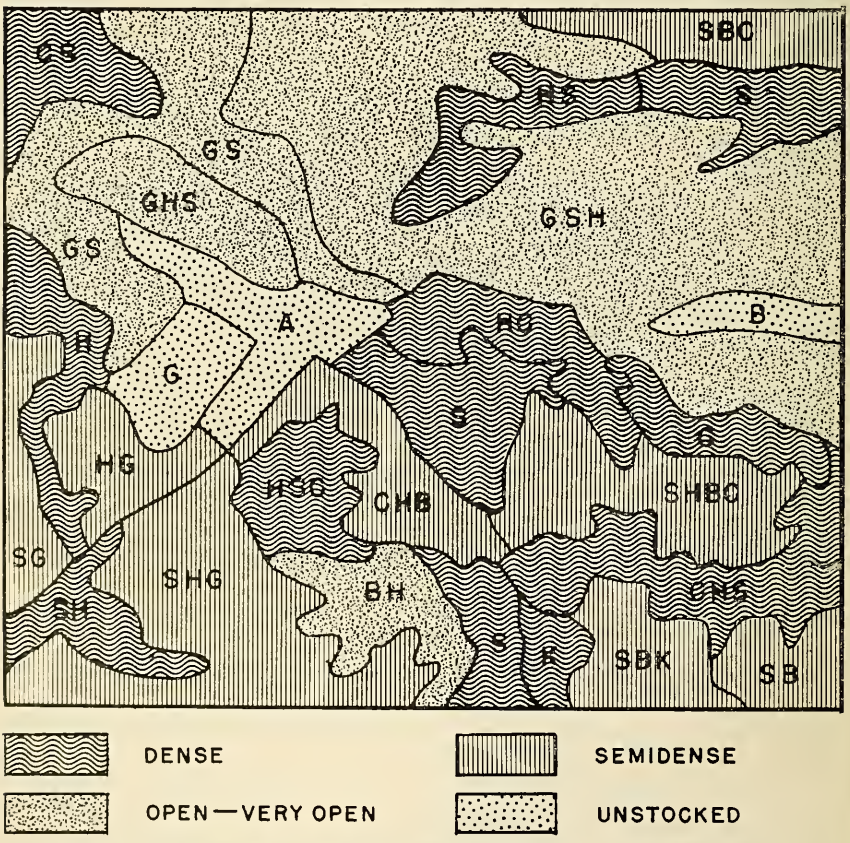


FIGURE 63. A sample map showing the classification of total tree and shrub density for the same area as that in Figures 60, 61 and 62

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

FIGURE 64. Commercial conifers (Ponderosa pine)

FIGURE 65. Noncommercial conifers (Monterey cypress)

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

FIGURE 66. H = Hardwoods (California white and California blue oaks)

FIGURE 67. S = Chaparral (White-leaf manzanita)

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

FIGURE 68. Sagebrush (Big sagebrush and bitterbrush)

FIGURE 69. Bushy herbs (Bracken)

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

FIGURE 70. Grass

FIGURE 71. Marsh (Rushes and cattail)

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

FIGURE 72. Bare ground

FIGURE 73. Rock

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

FIGURE 74. Cultivated

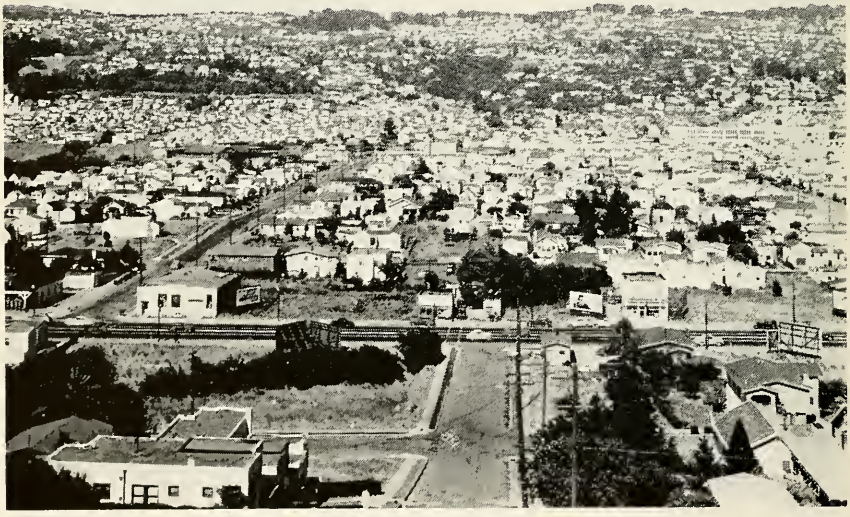
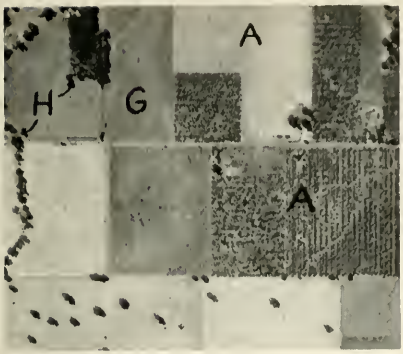
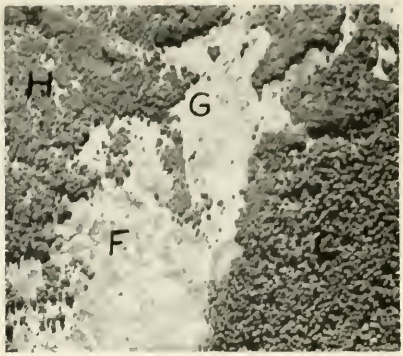


FIGURE 75. Urban-Industrial

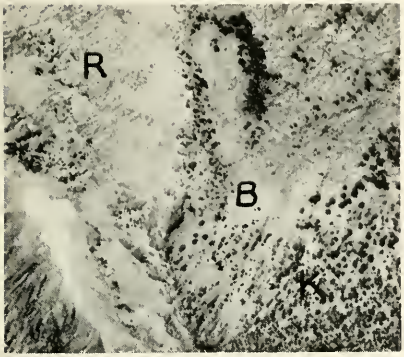
VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS



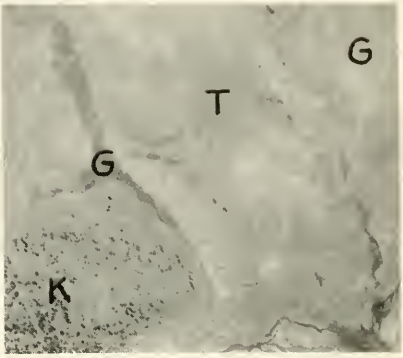
H = Hardwoods, G = Grass, A = Cultivated



C = Commercial conifers, H = Hardwoods, F = Bushy herbs, G = Grass



K = Noncommercial conifers, B = Bare ground, R = Rock



K = Noncommercial conifers, T = Sagebrush, G = Grass

C = Commercial conifers, H = Hardwoods, S = Chaparral

M = Marsh, U = Urban-Industrial

FIGURE 76. The vegetation-cover and other land status elements on 1:20,000 scale (approximately 3 inches = 1 mile) aerial photos

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

FIGURE 77. A single-element stand composed of commercial conifers

FIGURE 78. A multi-element stand composed of grass, chaparral, and hardwoods

FIGURE 79. The proper inventory of this area would show as many of the distinct areas as the job specifications require and omit the others; it would not show a mixture of hardwoods, grass, and chaparral.

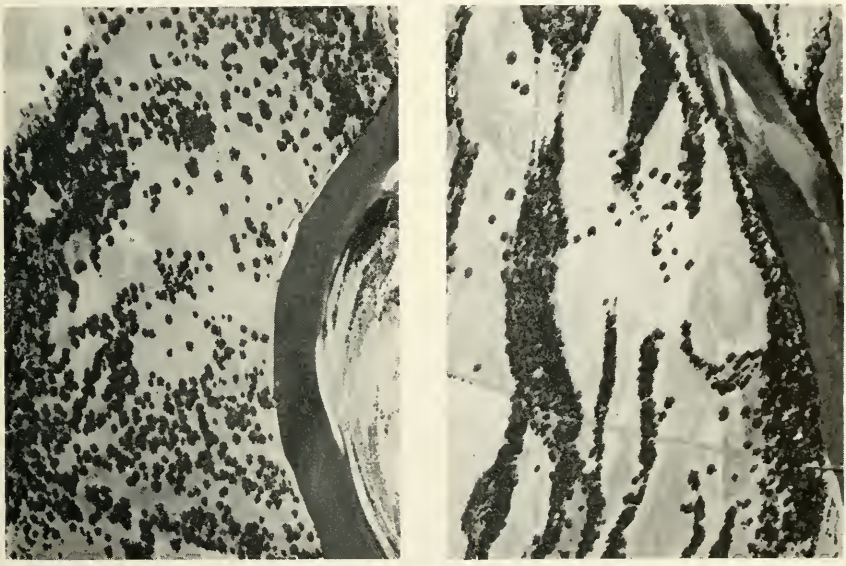


FIGURE 80. Aerial photo views of

(A) a true grass-hardwood mixture and

(B) an area that would be incorrectly classified as such a mixture even though some of the hardwood stringers would otherwise be too small to record.

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

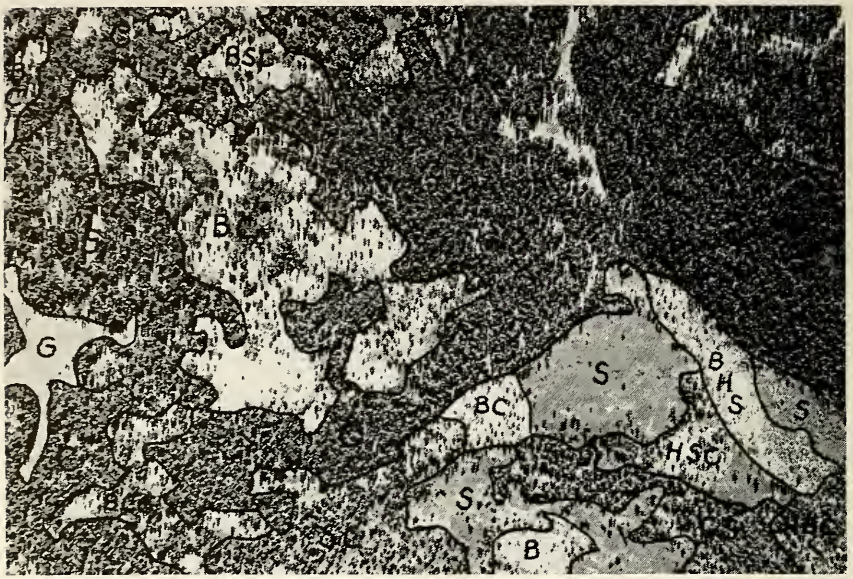


FIGURE 81. An example of a classified aerial photo from the Sierra Nevada. B = Bare ground, C = Commercial conifers, G = Grass, H = Hardwoods, S = Chaparral

FIGURE 82. An example of a classified aerial photo from the Sierra Nevada foothills. A = Cultivated, G = Grass, H = Hardwoods, S = Chaparral

VEGETATION-COVER AND OTHER LAND STATUS ELEMENTS

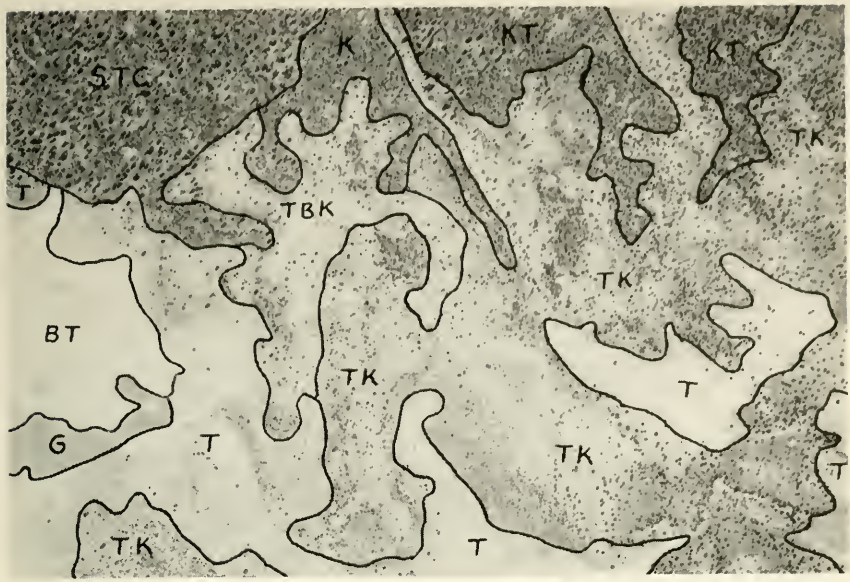


FIGURE 83. An example of a classified aerial photo from the northeastern plateau (Great Basin). B = Bare ground, C = Cultivated, G = Grass, H = Hardwoods, K = Noncommercial conifers, S = Chaparral, T = Sagebrush.

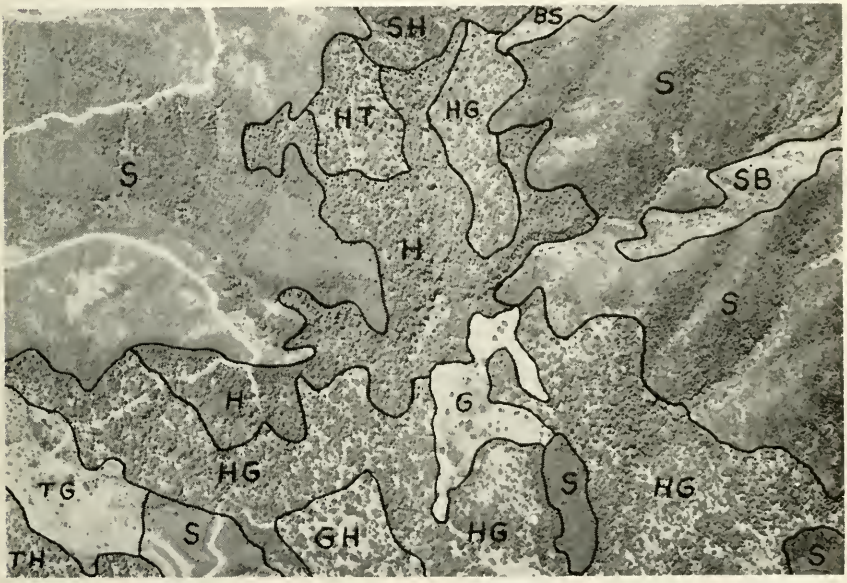


FIGURE 84. An example of a classified aerial photo from the south coastal mountains. B = Bare ground, G = Grass, H = Hardwoods, S = Chaparral, T = Sagebrush

VEGETATION SPECIES

FIGURE 85. A single-species stand where only one vegetation element (chaparral) is present. The chaparral species is deerbrush

FIGURE 86. A multi-species stand where only one vegetation element (chaparral) is present. The chaparral species are chamise and stripedberry manzanita

VEGETATION SPECIES

FIGURE 87. A multi-species stand where two vegetation elements (sagebrush and commercial conifers) are present. The sagebrush species is big sagebrush and the commercial conifer species is Jeffrey pine.

FIGURE 88. A multi-species stand where more than two vegetation elements (grass, hardwoods, chaparral, and noncommercial conifers) are present. The hardwood species are California black oak and California white oak, the chaparral species is wedgeleaf ceanothus, and the noncommercial conifer species is digger pine. No attempt is made to map the individual grass species. The ponderosa pines appearing on the photo cover too little of the area to be given recognition.

VEGETATION TYPES

FIGURE 89. Pine

FIGURE 90. Redwood

VEGETATION TYPES

FIGURE 91. Douglas-fir

FIGURE 92. Fir

VEGETATION TYPES

FIGURE 93. Pine—Douglas-fir

FIGURE 94. Pine—Fir and Pine—Douglas-fir—Fir. (These two types are generally similar except for the absence or presence of Douglas-fir.)

VEGETATION TYPES

FIGURE 95. Spruce

FIGURE 96. Lodgepole pine—Mountain hemlock

VEGETATION TYPES

FIGURE 97. Whitebark pine—Foxtail pine

FIGURE 98. Piñon pine

VEGETATION TYPES

FIGURE 99. Juniper (Sierra juniper)

FIGURE 100. Minor conifers (Bigcone-spruce)

VEGETATION TYPES

FIGURE 101. Woodland

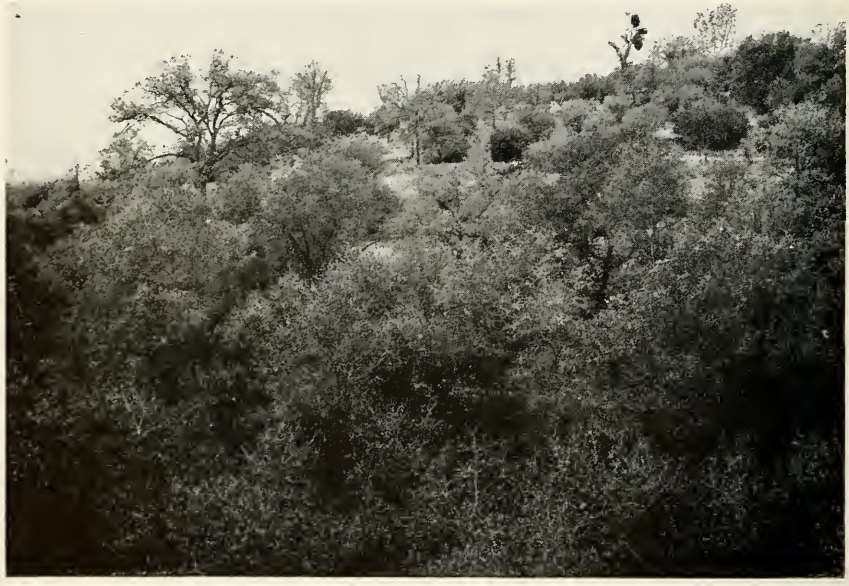


FIGURE 102. Woodland—Chaparral

VEGETATION TYPES

FIGURE 103. Woodland—Sagebrush

FIGURE 104. Woodland—Grass

VEGETATION TYPES

FIGURE 105. Tanoak—Madrone

FIGURE 106. Black oak—Oregon white oak

VEGETATION TYPES

FIGURE 107. Live oaks

FIGURE 108. Blue oak—California white oak

VEGETATION TYPES

FIGURE 109. Alder

FIGURE 110. Aspen—Cottonwood

VEGETATION TYPES

FIGURE 111. Chaparral (Other than chamise)

FIGURE 112. Chaparral (Chamise)

VEGETATION TYPES

FIGURE 113. Coastal sagebrush

FIGURE 114. Great Basin sagebrush

VEGETATION TYPES

FIGURE 115. Desert

FIGURE 116. Bushy herbs

VEGETATION TYPES

FIGURE 117. Grass

FIGURE 118. Marsh

VEGETATION TYPES

FIGURE 119. Barren

FIGURE 120. Cultivated and Urban-Industrial

TREE AND SHRUB DENSITIES

FIGURE 121. Dense woody cover; dense for trees alone, unstocked for shrubs alone

FIGURE 122. Semidense woody cover; very open for trees alone, semidense for shrubs alone

TREE AND SHRUB DENSITIES

FIGURE 123. Open woody cover; very open for trees alone, very open for shrubs alone

FIGURE 124. Very open woody cover; unstocked for trees alone, very open for shrubs alone

TREE AND SHRUB DENSITIES

FIGURE 125. Unstocked with woody cover

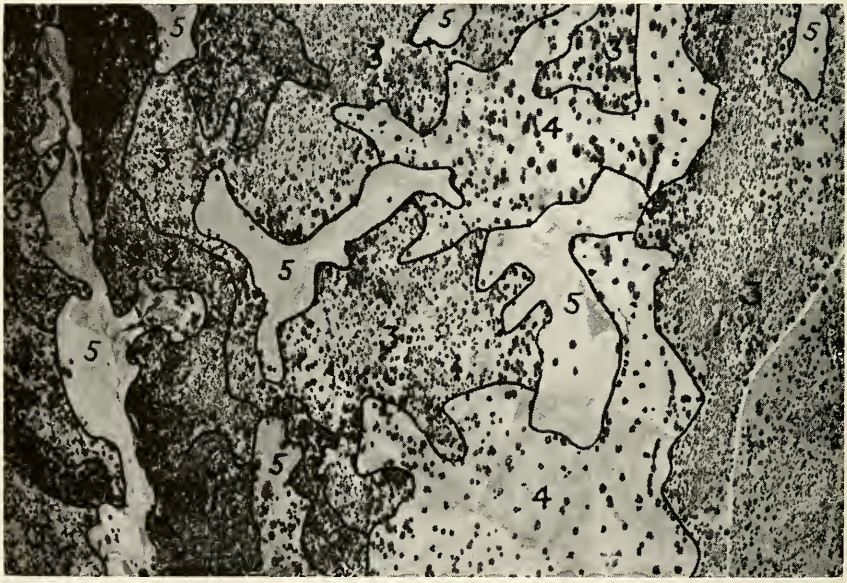


FIGURE 126. An example of the density classification on an aerial photo. 1, dense; 2, semidense; 3, open; 4, very open; 5, unstocked

The Units Recognized, Scheme 1

This scheme gives the essentially balanced division of density classes by which timber stands are now being stratified on aerial photos for the Forest Survey of California. Its classes and identifying symbols are:

1—*Dense*—Stands in which the crowns of the element or elements being considered cover 80 percent or more of the ground space.

2—*Semidense*—Stands in which the crowns of the element or elements being considered cover from 50 to 80 percent of the ground space.

3—*Open*—Stands in which the crowns of the element or elements being considered cover from 20 to 50 percent of the ground space.

4—*Very open*—Stands in which the crowns of the element or elements being considered cover from 5 to 20 percent of the ground space.

5—*Unstocked*—Areas having less than 5 percent of ground space covered by crowns of the element or elements being considered.

Figure 59 illustrates diagramatically what these percentage limits mean in terms of vertical views. Figures 121-125 show examples of the classes from ground views, and Figure 126 examples on an aerial photo.

TABLE 2

Schedule (Scheme 2) for Translating the Vegetation-Element Classes Into Density Classes

Number of woody elements considered together	Number of diluting elements in designation	Position of diluting elements in designation	Density class
Any	0		Dense
Any	1	Not in first place	Semidense
3 or 4	1	In first place	Semidense
1 or 2	1	In first place	Open—Very open
3	2	Any	Semidense
2	2	Any, except when one of woody elements is in first place	Open—Very open
			Semidense
1	2	Any	Open—Very open
1 or 2	3 or 4	Any	Open—Very open
0	Any		Unstocked

The Units Recognized, Scheme 2

This scheme is designed to classify the densities of all forms of woody vegetation through translation of the vegetation-element classification (Section I); at the same time fitting within the framework of the first scheme. With but minor exceptions and the grouping of open and very open densities together, both of these objectives are satisfied through application of the schedule in Table 2 to the vegetation-element classification. In this schedule "diluting elements" refers to all elements (woody or non-woody) excluded from whatever density classification is being made.

For example, in classifying the density of all woody cover, SH would be dense, CHBS semidense, GSK open—very open, and G unstocked. On the basis of shrub cover alone SH would be semidense, CHBS and GSK open—very open, and G unstocked.

Classification Principles

The principles governing the original classification of tree and shrub density under the first scheme presented are the same as those that apply

to the vegetation-element classification (Section I), so they are not restated here. The second scheme is automatically controlled by those same principles through its being wholly derived from that classification.

Classifying Techniques

Classifying density under the first scheme follows the same procedure outlined for the vegetation-element classification (Section I) except that it is most efficiently done concurrently with the latter rather than separately. Delineations are then made on the joint basis of vegetation-element composition and density, and the designations given both vegetation-element and density symbols. If separate density classifications are made of different parts of the woody cover, additional density symbols would be listed in regular order. For example, the complete designation for the area in Figure 78 would be GSH-3 if the only density classification was for total tree and shrub cover, or GSH-34 if it was first for total tree and shrub cover and second for tree cover.

As with the other original classifications, such guides as Figure 59 and samples measured on either the aerial photos or ground are essential tools in developing judgment of tree and shrub densities.

The second scheme requires only the addition of density symbols to the vegetation-element areas already outlined; the proper density in each case being determined through reference of the vegetation-element symbols to the foregoing schedule. Again, separate density classifications can be made of different parts of the tree and shrub cover. Figure 63 illustrates, with shading, such a density classification for the total tree and shrub cover applied to the same area as that covered by Figures 60, 61, and 62.

When compiling a map to emphasize the density classification the following color legend is suggested: Dense (blue), Semidense (green), Open (red), Very open (orange), and Unstocked (yellow).

Value of the Classification

The vegetation densities brought out by this classification have a wide range of uses. Densities of the commercial timber stands are pertinent to the inventorying, management, and use of timberlands. Density of the shrub cover on grasslands is one measure of range carrying capacity and of the range rehabilitation problem. Densities of tree and shrub cover have direct bearings on watershed values. All of them, as well as others, also touch upon game management problems, because of the close and direct dependence of game species on the vegetation cover.

Summary

The taking of inventories is an essential part of management, and classification a like part of inventorying. To assist game managers in their inventorying of vegetation cover, four sections of a classification system developed at the California Forest and Range Experiment Station for its Forest Survey and Vegetation Type Survey have been presented here. This system is distinguished from many other systems by its design to take advantage of aerial photos. But while developed for aerial-photo techniques, the system is also applicable to ground mapping.

The first classification is the basic one, segregating the vegetation-cover and other land status elements in whatever combinations they occur.

With a field background in photo interpretation, the classification is wholly obtainable from the aerial photos now generally available. This classification is usable either by itself or as a framework upon which the other classifications can be added.

The second classification supplements the first by adding the dominant species composition of the vegetation elements recorded in the first classification. Inasmuch as this involves something not generally recognizable on the aerial photos, ground mapping is here required. But having the prior delineation of vegetation elements greatly facilitates the ground mapping of species composition, and the photos are of other indirect help.

The third classification summarizes the vegetation-element and part of the species-composition classifications into vegetation types that are easily comprehended and used. A set of specifications now in use at the Experiment Station is presented but others can readily be drawn up for special needs. A single area can also be classified in several ways to bring out different features. Since this classification is merely a redesignation of the other two it can be made entirely through office translation or, if the full species classification is not being made, through a minimum of ground mapping.

The fourth classification, which segregates the tree and shrub densities, is presented in two schemes—(1) as a separate classification made concurrently with the vegetation-element classification through study of aerial photos, and (2) as obtainable through translation of the vegetation-element classification. Both have the same limits but the latter scheme is less complete.

Between these four classifications, most of the information needed in inventories of the natural vegetation cover for game management purposes is included. They are not intended to be all-inclusive. But through following such a system, much-needed uniformity in the broader aspects of related inventories can be achieved. At the same time wide latitude remains for making local modifications to fit either present or future needs.

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1942 Classifying forest and other vegetation from air photographs. Photogram Eng. 8:203-215.

TABLE 3

Common Names of Plants Mentioned in Article, Together With Their Scientific Equivalents

Common name	Scientific name
Alder	*Alnus* spp.
Aspen	*Populus tremuloides*
Bigcone-spruce	*Pseudotsuga macrocarpa*
Big sagebrush	*Artemisia tridentata*
Bishop pine	*Pinus muricata*
Bitterbrush	*Purshia tridentata*
Blue oak (Calif. Blue Oak)	*Quercus douglasii*
Bracken	*Pteris aquilina lanuginosa*
Bristlecone fir (Santa Lucia fir)	*Abies venusta*
Bristlecone pine	*Pinus aristata*
California black oak	*Quercus kelloggii*
California-laurel	*Umbellularia californica*
California sagebrush	*Artemisia californica*
California sycamore	*Platanus racemosa*
California white oak (Valley oak)	*Quercus lobata*
Canyon live oak	*Quercus chrysolepis*
Cattail	*Typha latifolia*
Chamise	*Adenostoma fasciculatum*
Coast live oak	*Quercus agrifolia*
Cottonwoods	*Populus* spp.
Coulter pine	*Pinus coulteri*
Coyote brush (Kidneywort)	*Baccharis pilularis*
Creosotebush	*Larrea tridentata glutinosa*
Cypresses	*Cupressus* spp.
Deerbrush (Sweetbirch ceanothus)	*Ceanothus integerrimus*
Digger pine	*Pinus sabiniana*
Douglas-fir	*Pseudotsuga taxifolia*
Evergreen white oak	*Quercus engelmannii*
Ferns	*Pteridophyta*
Firs (True)	*Abies* spp.
Foxtail pine	*Pinus balfouriana*
Giant sequoia	*Sequoia washingtonia* (*S. gigantea*)
Grasses	Gramineae
Interior live oak	*Quercus wislizenii*
Jeffrey pine	*Pinus jeffreyi*
Joshua-tree	*Yucca brevifolia*
Junipers	*Juniperus* spp.
Klamath weed	*Hypericum perforatum*
Knobcone pine	*Pinus attenuata*
Limber pine	*Pinus flexilis*
Lodgepole pine	*Pinus contorta murrayana*
Madrone (Pacific madrone)	*Arbutus menziesii*
Manzanitas	*Arctostaphylos* spp.
Monterey cypress	*Cupressus macrocarpa*
Monterey pine	*Pinus radiata*
Mountain hemlock	*Tsuga mertensiana*
Mountain-mahogany	*Cercocarpus* spp.
Oaks	*Quercus* spp.
Oregon white oak (Garry oak)	*Quercus garryana*
Piñon pines	*Pinus monophylla* and *P. parryana*
Ponderosa pine	*Pinus ponderosa*
Red alder	*Alnus rubra*
Red fir (California red fir)	*Abies magnifica*
Redwood	*Sequoia sempervirens*
Rushes	Juncaceae
Sagebrushes	*Artemisia* spp.
Samphire	*Salicornia* spp.
Scrub oak	*Quercus dumosa*
Sedges	Cyperaceae
Sierra juniper	*Juniperus occidentalis*
Sitka spruce	*Picea sitchensis*
Stripedberry manzanita	*Arctostaphylos pilosula*
Sugar pine	*Pinus lambertiana*
Tanoak	*Lithocarpus densiflora*
Torrey pine	*Pinus torreyana*
Wedgeleaf ceanothus	*Ceanothus cuneatus*
Western white pine	*Pinus monticola*
White alder	*Alnus rhombifolia*
White fir	*Abies concolor* (inc. *A. grandis*)
Whitebark pine	*Pinus albicaulis*
White-leaf manzanita	*Arctostaphylos viscida*
Wild-buckwheats	*Eriogonum* spp.
Willows	*Salix* spp.
Wooly mules-ears	*Wyethia mollis*

TABLE 4

A. Alphabetical List by Genus of Plants Other Than Grasses

A

W[1]	*Abies concolor* T
G[1]	*Abies grandis* T
R[1]	*Abies magnifica* T
S[1]	*Abies magnifica shastensis* T
N[1]	*Abies nobilis* T
B[1]	*Abies venusta* T
Aba	*Abronia alpina* H
Abm	*Abronia maritima* H
Abp	*Abronia pogonantha* H
Abv	*Abronia villosa* H
Agr	*Acacia greggii* S
Acp	*Acaena pinnatifida californica* H
Acs	*Acamptopappus sphaerocephalus* Ss
Aci	*Acer circinatum* S
Acg	*Acer glabrum* S
M[2]	*Acer macrophyllum* T
N[2]	*Acer negundo californicum* T
Aml	*Achillea millefolium lanulosa* H
Act	*Achlys triphylla* H
Acm	*Achyrachaena mollis* H
Acc	*Achyronychia cooperi* H
Acl	*Aclcisanthes longiflora* Ss
Asa	*Actaea spicata arguta* H
Ahe	*Adenostegia helleri* H
Af	*Adenostoma fasciculatum* S
As	*Adenostoma sparsifolium* S
Adx	*Adiantum* sp. H
Adc	*Adolphia californica* Ss
Aec	*Aesculus californica* S
H[2]	*Aesculus californica* T
Agu	*Agastache urticifolia* H
Agx	*Agoseris* sp. H
Aga	*Agoseris apargioides* H
Aggl	*Agoseris g auca laciniata* H
Aggr	*Agoseris grandiflora* H
Agh	*Agoseris heterophylla* H
Ahi	*Agoseris hirsuta* H
Agg	*Agrostemma githago* H
Th	*Ailanthus glandulosa* T
Alc	*Alhagi camelorum* Ss
Alo	*Allenrolfia occidentalis* Ss
Alx	*Allium* sp. H
Alv	*Allium validum* H
Allx	*Allocarya* sp. H
A[2]	*Alnus rhombifolia* T
R[2]	*Alnus rubra* T
Ate	*Alnus tenuifolia* S
Avs	*Alnus viridis sinuata* S
Amp	*Ambrosia psilostachya* H
Aa	*Amelanchier alnifolia* S
Aca	*Amorpha californica* S
Afr	*Amorpha fruticosa* S
Ams	*Amsinckia douglasiana* H
Ain	*Amsinckia intermedia* H
Amx	*Amsinckia* sp. H
Ana	*Anagallis arvensis* H
Anm	*Anaphalis margaritacea* H
Anca	*Anemopsis californica* H
Anb	*Angelica breweri* H
Anl	*Angelica lineariloba* H
Ant	*Angelica tomentosa* H
Aac	*Anisocoma acaulis* H
Aal	*Antennaria alpina* H
And	*Antennaria dioica* H
Anc	*Anthemis cotula* H
Ang	*Antirrhinum glandulosum* H
Ans	*Antirrhinum speciosum* H
Apap	*Apocynum androsaemifolium pumilum* H
Apc	*Apocynum cannabinum* H
Aqt	*Aquilegia truncata* H
Abl	*Arabis blepharophylla* H
Abr	*Arabis breweri* H
Ahf	*Arabis holboellii fendleri* H
Ahr	*Arabis holboellii retrofracta* H
Arl	*Aralia californica* H
M	*Arbutus menziesii* T
Arm	*Arctomecon merriamii* H
Aan	*Arctostaphylos andersonii* S
Aap	*Arctostaphylos andersonii pechoensis* S
Aaa	*Arctostaphylos auriculata* S
Ab	*Arctostaphylos bicolor* S
Acn	*Arctostaphylos canescens* S
Aco	*Arctostaphylos columbiana* S
Ade	*Arctostaphylos densifolia* S
Ad	*Arctostaphylos drupacea* S
Ae	*Arctostaphylos elegans* S
Agl	*Arctostaphylos glandulosa* S
Ag	*Arctostaphylos glauca* S
Ah	*Arctostaphylos hookeri* S
Aim	*Arctostaphylos imbricata* S
Ai	*Arctostaphylos insularis* S
Am	*Arctostaphylos manzanita* S
Ama	*Arctostaphylos mariposa* S
Amb	*Arctostaphylos mariposa bivisum* S
Amr	*Arctostaphylos morroensis* S
Amy	*Arctostaphylos myrtifolia* S
An	*Arctostaphylos nevadensis* S
Ani	*Arctostaphylos nissenana* S
Anu	*Arctostaphylos nummularia* S
Aob	*Arctostaphylos obispoensis* S
Ao	*Arctostaphylos otayensis* S
Apj	*Arctostaphylos pajaroensis* S
Apl	*Arctostaphylos pallida* S
Apy	*Arctostaphylos parryana* S
App	*Arctostaphylos parryana pinetorum* S
Aps	*Arctostaphylos pastillosa* S
Ap	*Arctostaphylos patula* S
Ape	*Arctostaphylos pechoensis* S
Api	*Arctostaphylos pilosula* S
Apm	*Arctostaphylos pumila* S
Apu	*Arctostaphylos pungens* S
Are	*Arctostaphylos regismontana* S
Ar	*Arctostaphylos rudis* S
Ase	*Arctostaphylos sensitiva* S
Asi	*Arctostaphylos silvicola* S
Ast	*Arctostaphylos stanfordiana* S
At	*Arctostaphyos tomentosa* S
Au	*Arctostaphylos uva-ursi* S
Av	*Arctostaphylos viscida* S
Ay	*Arctostaphylos ynezensis* S
Arco	*Arenaria congesta* H
Ardo	*Arenaria douglasii* H

The plants in the list have been classified as herbs (H), shrubs (S), and trees (T), with a subdivision of shrubs into those that may be classified as sagebrush type species (Ss). The classification of many species, however, is as yet questionable and is subject to change following further study.

[1] This symbol carries accent, i.e., $\hat{X}$.

[2] This symbol carries underline, i.e., $\underline{X}$.

TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Arn	*Arenaria nuttallii*	H
Arx	*Arenaria* sp.	H
Aic	*Argemone intermedia corymbosa*	H
Arp	*Argemone platyceras*	H
Aph	*Argemone platyceras hispida*	H
Arca	*Aristolochia californica*	S
Ard	*Arnica discoidea*	H
Aar	*Artemisia arbuscula*	Ss
Ac	*Artemisia californica*	Ss
Arc	*Artemisia cana*	Ss
Adr	*Artemisia dracunculus*	H
Aty	*Artemisia pycnocephala*	H
Arr	*Artemisia rothrockii*	Ss
Arsp	*Artemisia spinescens*	Ss
Atr	*Artemisia tridentata*	Ss
Ato	*Artemisia tridentata nova*	Ss
Apa	*Artemisia tridentata parishii*	Ss
Atf	*Artemisia trifida*	Ss
Avu	*Artemisia vulgaris*	H
Avh	*Artemisia vulgaris heterophylla*	H
Asy	*Aruncus sylvester*	H
Asac	*Asarum caudatum*	H
Ascc	*Asclepias californica*	H
Asc	*Asclepias cordifolia*	H
Aser	*Asclepias eriocarpa*	H
Ases	*Asclepias erosa*	H
Asf	*Asclepias fremontii*	H
Asm	*Asclepias mexicana*	H
Ara	*Aspidium rigidum argutum*	H
Asx	*Aspidium* sp.	H
Asad	*Aster adscendens*	H
Asca	*Aster canescens*	H
Asl	*Aster chilensis*	H
Asco	*Aster cognatus*	H
Ame	*Aster menziesii*	H
Asr	*Aster radulinus*	H
Art	*Aster tortifolius*	S
Asbo	*Astragalus bolanderi*	H
Ask	*Astragalus hookerianus*	H
Aho	*Astragalus hornii*	H
Ake	*Astragalus kernensis*	H
Ale	*Astragalus lentiginosus*	H
Alu	*Astragalus leucophyllus*	H
Amz	*Astragalus menziesii*	H
Amo	*Astragalus mohavensis*	H
Asn	*Astragalus nigrescens*	H
Aox	*Astragalus oxyphysus*	H
Aspu	*Astragalus purshii*	H
Ax	*Astragalus* sp.	H
Astr	*Astragalus trichopodus*	H
Affc	*Athyrium filix-foemina californicum*	H
Ata	*Atriplex argentea*	H
Atk	*Atriplex bracteosa*	H
Atb	*Atriplex breweri*	Ss
Atc	*Atriplex canescens*	Ss
Aff	*Atriplex confertifolia*	Ss
Atex	*Atriplex expansa*	H
Atha	*Atriplex hastata*	H
Ath	*Atriplex hymenelytra*	Ss
Atl	*Atriplex lentiformis*	Ss
Atn	*Atriplex nuttallii*	Ss
Apr	*Atriplex parryi*	Ss
Atpa	*Atriplex patula*	H
Atp	*Atriplex polycarpa*	Ss
Ats	*Atriplex semibaccata*	H
Atx	*Atriplex* sp.	H, Ss
Asp	*Atriplex spinifera*	Ss
Att	*Atriplex torreyi*	Ss
Aya	*Ayenia californica*	Ss

B

Bd	*Baccharis douglasii*	Ss
Be	*Baccharis emoryi*	Ss
Bag	*Baccharis glutinosa*	Ss
Bp	*Baccharis pilularis*	Ss
Bpl	*Baccharis plummerae*	Ss
Bsa	*Baccharis sarothroides*	Ss
Bas	*Baccharis sergiloides*	Ss
Bv	*Baccharis viminea*	Ss
Bac	*Baeria chrysostoma*	H
Bap	*Baeria platycarpha*	H
Bax	*Baeria* sp.	H
Bho	*Balsamorhiza hookeri*	H
Bsg	*Balsamorhiza sagittata*	H
Bav	*Barbarea vulgaris*	H
Bj	*Bebbia juncea*	Ss
Bec	*Beloperone californica*	Ss
Baq	*Berberis aquifolium*	Ss
Bcf	*Berberis californica*	S
Bf	*Berberis fremontii*	S
Bn	*Berberis nervosa*	S
Ben	*Berberis nevinii*	S
Bpi	*Berberis pinnata*	S
Bpu	*Berberis pumila*	S
Ber	*Berberis repens*	S
Bem	*Bernardia myricaefolia*	Ss
B[2]	*Betula fontinalis*	T
Bgl	*Betula glandulosa*	S
Bif	*Bidens frondosa*	H
Bil	*Bidens levis*	H
Blc	*Bloomeria crocea*	H
Bad	*Brassica adpressa*	H
Bca	*Brassica campestris*	H
Bng	*Brassica nigra*	H
Brx	*Brassica* sp.	H
Baa	*Brickellia atractyloides arguta*	Ss
Bc	*Brickellia californica*	Ss
Bfr	*Brickellia frutescens*	Ss
Bg	*Brickellia grandiflora*	H
Brm	*Brickellia microphylla*	Ss
Bmu	*Brickellia multiflora*	Ss
Bne	*Brickellia nevinii*	Ss
Bol	*Brickellia oblongifolia linifolia*	Ss
Bkx	*Brickellia* sp.	H, Ss
Brc	*Brodiaea capitata*	H
Bco	*Brodiaea coronaria*	H
Bhy	*Brodiaea hyacinthina*	H
Bi	*Brodiaea ixioides*	H
Bl	*Brodiaea laxa*	H
Brp	*Brodiaea pulchella*	H
Bvo	*Brodiaea volubilis*	H

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[2] This symbol carries underline, i.e., B.

TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

C

Cac	*Calandrinia caulescens*	H
Calb	*Calochortus albus*	H
Caca	*Calochortus caeruleus*	H
Ccat	*Calochortus catalinae*	H
Caco	*Calochortus concolor*	H
Ckc	*Calochortus kennedyi*	H
Call	*Calochortus leichtlinii*	H
Calu	*Calochortus luteus*	H
Cama	*Calochortus macrocarpus*	H
Camo	*Calochortus monophyllus*	H
Cnu	*Calochortus nudus*	H
Cap	*Calochortus plummerae*	H
Cpu	*Calochortus pulchellus*	H
Ckx	*Calochortus* sp.	H
Cls	*Calochortus splendens*	H
Cav	*Calochortus venustus*	H
Cabi	*Caltha biflora*	H
Cmo	*Calycadenia mollis*	H
Clm	*Calycadenia multiglandulosa*	H
Clp	*Calycadenia oppositifolia*	H
Clx	*Calycadenia* sp.	H
Cat	*Calycadenia truncata*	H
Cao	*Calycanthus occidentalis*	S
Cal	*Calyptridium umbellatum*	H
Cale	*Camassia leichtlinii*	H
Caq	*Camassia quamash*	H
Cah	*Canotia holocantha*	S
Cab	*Capsella bursa-pastoris*	H
Cxb	*Carex barbarae*	H
Cax	*Carex* sp.	H
Cel	*Carpenteria californica*	S
Caga	*Carum gairdneri*	H
Caa	*Cassia armata*	Ss
Ctp	*Cassiope mertensiana*	S
Q	*Castanopsis chrysophylla*	T
Cem	*Castanopsis chrysophylla minor*	S
Cs	*Castanopsis sempervirens*	S
Caf	*Castilleia affinis*	H
Can	*Castelleia angustifolia*	H
Cfl	*Castellcia foliolosa*	H
Cala	*Castilleia latifolia*	H
Cami	*Castilleia miniata*	H
Cpdo	*Castilleia parviflora douglasii*	H
Capi	*Castilleia pinetorum*	H
Cam	*Caucalis microcarpa*	H
Car	*Ceanothus arboreus*	S
Ca	*Ceanothus austromontanus*	S
Ceo	*Ceanothus cordulatus*	S
Cer	*Ceanothus crassifolius*	S
Cc	*Ceanothus cuneatus*	S
Cey	*Ceanothus cyaneus*	S
Cde	*Ceanothus dentatus*	S
Cim	*Ceanothus dentatus impressus*	S
Cd	*Ceanothus divaricatus*	S
Cdi	*Ceanothus diversifolius*	S
Cfe	*Ceanothus ferrisae*	S
Cfo	*Ceanothus foliosus*	S
Cg	*Ceanothus greggii*	S
Cgp	*Ceanothus greggii perplexans*	S
Cin	*Ceanothus incanus*	S
Ci	*Ceanothus integerrimus*	S
Cj	*Ceanothus jepsonii*	S
Cjp	*Ceanothus jepsonii purpureu*	S
Cle	*Ceanothus lemmoni*	S
Clo	*Ceanothus lompocensis*	S
Cm	*Ceanothus macrocarpus*	S
Co	*Ceanothus oliganthus*	S
Cpl	*Ceanothus papillosus*	S
Cpr	*Ceanothus parryi*	S
Cpv	*Ceanothus parvifolius*	S
Cpi	*Ceanothus pinetorum*	S
Cpo	*Ceanothus prostratus*	S
Cpd	*Ceanothus prostratus divergens*	S
Cpg	*Ceanothus prostratus grandifolius*	S
Cri	*Ceanothus rigidus*	S
Crf	*Ceanothus rigidus franciscanus*	S
Csa	*Ceanothus sanguineus*	S
Cse	*Ceanothus serrulatus*	S
Cso	*Ceanothus sorediatus*	S
Cx	*Ceanothus* sp.	S
Csp	*Ceanothus spinosus*	S
Cpa	*Ceanothus spinosus palmeri*	S
Ct	*Ceanothus thyrsiflorus*	S
Cte	*Ceanothus thyrsiflorus chandleri*	S
Cto	*Ceanothus tomentosus*	S
Ctl	*Caenothus tomentosus olivaceus*	S
Cv	*Ceanothus velutinus*	S
Cvv	*Ceanothus velutinus lucigatus*	S
Cvl	*Ceanothus velutinus lorenzenii*	S
Cve	*Ceanothus verrucosus*	S
Cvt	*Ceanothus vestitus*	S
Hw	*Celtis mississippiensis reticulata*	T
Cem	*Centaurea melitensis*	H
Ces	*Centaurea solstitialis*	H
Cev	*Centaurium venustum*	H
Cef	*Centromadia fitchii*	H
Cep	*Centromadia pungens*	H
Ceo	*Cephalanthus occidentalis*	S
Cea	*Cerastium arvense*	H
Cvis	*Cerastium viscosum*	H
Pv	*Cercidium torreyanum*	T
Cec	*Cercis occidentalis*	S
Cb	*Cercocarpus betuloides*	S
Cci	*Cercocarpus intricatus*	S
Cl	*Cercocarpus ledifolius*	S
Cmi	*Cercocarpus minutiflorus*	S
Cce	*Cercus emoryi*	Ss
Ce	*Cercus engelmannii*	Ss
Cg	*Cereus gigantea*	T
Cha	*Chaenactis artemisiaefolia*	H
Che	*Chaenactis carphoclinia*	H
Chd	*Chaenactis douglasii*	H
Chg	*Chaenactis glabriuscula*	H
Cne	*Chaenactis nevadensis*	H
Chs	*Chaenactis santolinoides*	H
Csu	*Chaenactis suffrutescens*	H
Cxa	*Chaenactis xantiana*	H
Cf	*Chamaebatia foliolosa*	S
Cfa	*Chamaebatia foliolosa australis*	S
Chm	*Chamaebatiaria millefolium*	S
O	*Chamaecyparis lawsoniana*	T
Chmn	*Chamaesaracha nana*	H

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TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Kea	*Chenopodium album*	H
Kam	*Chenopodium ambrosioides*	H
Kca	*Chenopodium californicum*	H
Cpx	*Chenopodium* sp.	H
Chl	*Chilopsis linearis*	S
Cum	*Chimaphila umbellata*	S
Chpo	*Chlorogalum pomeridianum*	H
Czm	*Chorizanthe membranacea*	H
Czs	*Chorizanthe staticoides*	H
Cbr	*Chrysopsis breweri*	H
Cvi	*Chrysopsis villosa*	H
Chb	*Chrysothamnus bloomeri*	Ss
Chn	*Chrysothamnus nauseosus*	Ss
Cnc	*Chrysothamnus nauseosus consimilis*	Ss
Cng	*Chrysothamnus nauseosus gnaphalodes*	Ss
Cnh	*Chrysothamnus nauseosus hololeucus*	Ss
Cno	*Chrysothamnus nauseosus occidentalis*	Ss
Cns	*Chrysothamnus nauseosus speciosus*	Ss
Chp	*Chrysothamnus parryi*	Ss
Cpm	*Chrysothamnus parryi monocephalus*	Ss
Chx	*Chrysothamnus* sp.	Ss
Chv	*Chrysothamnus viscidiflorus*	Ss
Cvp	*Chrysothamnus viscidiflorus puberulus*	Ss
Cic	*Cicuta californica*	H
Cid	*Cicuta douglasii*	H
Cibr	*Cirsium breweri*	H
Cioc	*Cirsium occidentale coulteri*	H
Cix	*Cirsium* sp.	H
Cel	*Clarkia elegans*	H
Cla	*Clematis lasiantha*	S
Cli	*Clematis ligusticifolia*	S
Cpf	*Clematis pauciflora*	S
Cob	*Cleomella obtusifolia*	H
Clpl	*Cleome platycarpa*	H
Cdu	*Cneoridium dumosum*	S
Cnb	*Cnicus benedictus*	H
Cra	*Coleogyne ramosissima*	Ss
Coi	*Collinsia bicolor*	H
Ctt	*Collinsia tinctoria*	H
Cgr	*Collomia grandiflora*	H
Cod	*Comarostaphylis diversifolia*	S
Cly	*Condalia lycioides*	S
Cpy	*Condalia parryi*	S
Com	*Conium maculatum*	H
Coa	*Convolvulus arvensis*	H
Col	*Convolvulus luteolus*	H
Coo	*Convolvulus occidentalis*	H
Cov	*Convolvulus villosus*	H
Cop	*Cordylanthus pilosus*	H
Cbi	*Coreopsis bigelovii*	H
Coca	*Coreopsis calliopsidea*	H
Cog	*Coreopsis gigantea*	Ss
Cosp	*Coreopsis* sp.	H, Ss
Coc	*Corethrogyne californica*	H
Cof	*Corethrogyne filaginifolia*	H
Cca	*Cornus californica*	S
Cgl	*Cornus glabrata*	S
Cn	*Cornus nuttallii*	S
Cos	*Cornus sessilis*	S
Cr	*Corylus rostrata californica*	S
Crt	*Corylus rostrata tracyi*	S
Cot	*Cotula coronopifolia*	H
Kof	*Cotyledon farinosa*	H
Kol	*Cotyledon lanceolata*	H
Klx	*Cotyledon laxa*	H
Kop	*Cotyledon pulverulenta*	H
Cst	*Cowania mexicana stansburiana*	S
Cdo	*Crataegus douglasii*	S
Crb	*Crossosoma bigelovii*	S
Crca	*Crossosoma californicum*	S
Crc	*Croton californicus*	Ss
Crn	*Cryptantha intermedia*	H
Cma	*Cryptantha micrantha*	H
Crp	*Cryptantha pterocarya*	H
Qkf	*Cucurbita foetidissima*	H
Qkp	*Cucurbita palmata*	H
Ty	*Cupressus forbesii*	T
Gy	*Cupressus goveniana*	T
Ny	*Cupressus macnabiana*	T
By	*Cupressus macnabiana bakeri*	T
My	*Cupressus macrocarpa*	T
Ky	*Cupressus nevadensis*	T
Py	*Cupressus pygmaea*	T
Sy	*Cupressus sargentii*	
Dy	*Cupressus sargentii duttoni*	T
Cy	*Cycladenia humilis*	H
Cyg	*Cynoglossum grande*	H
Cyo	*Cynoglossum occidentale*	H
Csc	*Cytisus scoparius*	S

D

Dac	*Darlingtonia californica*	H
Dag	*Datisca glomerata*	H
Dam	*Datura meteloides*	H
Dap	*Daucus pusillus*	H
Dhc	*Delphinium californicum*	H
Dhd	*Delphinium decorum*	H
Dha	*Delphinium hansenii*	H
Dhh	*Delphinium hesperium*	H
Dhn	*Delphinium nudicaule*	H
Dhp	*Delphinium parryi*	H
Dht	*Delphinium trolliifolium*	H
Dhv	*Delphinium variegatum*	H
Dr	*Dendromecon rigida*	S
Dic	*Dentaria integrifolia californica*	H
Dc	*Dicentra chrysantha*	H
Dfo	*Dicentra formosa*	H
Da	*Diplacus aurantiacus*	Ss
Dl	*Diplacus longiflorus*	Ss
Dpu	*Diplacus puniceus*	Ss
Dif	*Dipsacus fullonum*	Ss
Do	*Dirca occidentalis*	S
Doc	*Dodecatheon hendersonii*	H
Drb	*Draba breweri*	H
Drc	*Draba cuneifolia*	H
Dco	*Draba corrugata*	H
Drg	*Draba glacialis*	H
Drl	*Draba lemmonii*	H
Dyc	*Dysodia cooperi*	H

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TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

E

Ecy	*Echinocactus cylindraceus*	Ss
Ecp	*Echinocactus polycephalus*	Ss
Efa	*Echinocystis fabacea*	H
Ema	*Echinocystis macrocarpa*	H
Eor	*Echinocystis oreganus*	H
Ech	*Ellisia chrysanthemifolia*	H
Elm	*Ellisia membranacea*	H
Emp	*Emmenanthe penduliflora*	H
Emn	*Empetrum nigrum*	S
Ea	*Eneclia actoni*	Ss
Enc	*Encelia californica*	Ss
Enf	*Encelia farinosa*	Ss
Efr	*Encelia frutescens*	Ss
Eca	*Ephedra californica*	Ss
Ene	*Ephedra nevadensis*	Ss
Epv	*Ephedra viridis*	Ss
Ean	*Epilobium angustifolium*	H
Epb	*Epilobium brevistylum*	H
Epc	*Epilobium californicum*	H
Epp	*Epilobium paniculatum*	H
Erar	*Erechtites arguta*	H
Erp	*Erechtites prenanthoides*	H
Ese	*Eremocarpus setigerus*	H
Ear	*Erecameria arborescens*	S
Eb	*Ericameria brachylepis*	S
Erc	*Ericameria cooperi*	Ss
Ecu	*Ericameria cuneata*	Ss
Ecs	*Ericameria cuneata spathulata*	Ss
Ee	*Ericameria ericoides*	Ss
Emo	*Ericameria monactis*	Ss
Epa	*Ericameria palmeri*	Ss
Erpa	*Ericameria paniculata*	Ss
Epr	*Ericameria parishii*	Ss
Epi	*Ericameria pinifolia*	Ss
Ert	*Ericameria teretifolia*	Ss
Erca	*Erigeron canadensis*	H
Erk	*Erigeron concinnus*	H
Eka	*Erigeron concinnus aphanactis*	H
Erf	*Erigeron foliosus*	H
Egl	*Erigeron glaucus*	H
Ein	*Erigeron inornatus*	H
Err	*Erigeron radicatus*	H
Ers	*Erigeron salsuginosus*	H
Ec	*Eriodictyon californicum*	Ss
Ecr	*Eriodictyon crassifolium*	Ss
Eto	*Eriodictyon tomentosum*	Ss
Et	*Eriodictyon trichocalyx*	Ss
Etl	*Eriodictyon trichocalyx lanatum*	Ss
Era	*Eriogonum arborescens*	Ss
Eba	*Eriogonum baileyi*	H
Efc	*Eriogonum cinereum*	S
Ed	*Eriogonum deflexum*	H
Erd	*Eriogonum douglasii*	H
Eel	*Eriogonum elatum*	H
Ere	*Eriogonum elongatum*	S
Ef	*Eriogonum fasciculatum*	Ss
Eff	*Eriogonum fasciculatum foliolosum*	Ss
Efp	*Eriogonum fasciculatum polifolium*	Ss
Egi	*Eriogonum giganteum*	Ss
Eg	*Eriogonum gracile*	H
Ehe	*Eriogonum heermannii*	Ss
Ei	*Eriogonum inflatum*	H
Erke	*Eriogonum kennedyi*	H
Elo	*Eriogonum lobbii*	H
Erm	*Eriogonum marifolium*	H
Emi	*Eriogonum microthecum*	Ss
Emv	*Eriogonum mohavense*	H
En	*Eriogonum nudum*	H
Eov	*Eriogonum ovalifolium*	H
Ep	*Eriogonum parvifolium*	Ss
Erx	*Eriogonum* sp.	H, Ss
Eum	*Eriogonum umbellatum*	H
Eru	*Eriogonum ursinum*	H
Evm	*Eriogonum vimineum*	H
Ev	*Eriogonum virgatum*	H
Ew	*Eriogonum wrightii*	Ss
Eco	*Eriophyllum confertiflorum*	Ss
Elc	*Eriophyllum lanatum cuneatum*	H
Elg	*Eriophyllum lanatum grandiflorum*	H
El	*Eriophyllum lanatum integrifolium*	H
Esa	*Eriophyllum staechadifolium*	Ss
Ero	*Erodium botrys*	H
Eci	*Erodium cicutarium*	H
Ems	*Erodium moschatum*	H
Ery	*Eryngium castrense*	H
Erj	*Eryngium jepsonii*	H
Erv	*Eryngium vaseyi*	H
Eas	*Erysimum asperum*	H
Eryc	*Erysimum capitatum*	H
Esc	*Eschscholtzia californica*	H
Esl	*Eschscholtzia lobbii*	H
Esm	*Eschscholtzia minutiflora*	H
Eu	*Eucalyptus* sp.	T
Eur	*Eucnide urens*	Ss
Eue	*Eulobus californicus*	H
Eo	*Euonymus occidentalis*	S
Eua	*Euphorbia albomarginata*	H
Euer	*Euphorbia crenulata*	H
Em	*Euphorbia misera*	Ss
Eup	*Euphorbia palmeri*	H
Eus	*Euphorbia scrpyllifolia*	H
Ux	*Euphorbia* sp.	H, Ss
Eul	*Eurotia lanata*	Ss
Evsp	*Evax sparsiflorus*	H

F

Fac	*Fagonia californica*	Ss
Fap	*Fallugia paradoxa*	Ss
Fic	*Filago californica*	H
Fig	*Filago gallica*	H
Fnm	*Forestiera neo-mexicana*	S
Fs	*Fouquieria splendens*	Ss
Fca	*Fragaria californica*	H
Frc	*Fragaria chilensis*	H
Fg	*Frankenia grandifolia*	Ss
Fgc	*Frankenia grandifolia campestris*	Ss
Fpa	*Frankenia palmeri*	Ss
Fra	*Franseria acanthicarpa*	H
Fbi	*Franseria bipinnatifida*	H
Fch	*Franseria chenopodiifolia*	Ss

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TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Fdu	*Franseria dumosa*	Ss
D[3]	*Fraxinus anomala*	T
Fd	*Fraxinus dipetala*	S
O[3]	*Fraxinus oregona*	T
V[3]	*Fraxinus velutina*	T
Fco	*Fraxinus velutina coriacea*	S
Fc	*Fremontia californica*	S
Fcm	*Fremontia californica mexicana*	S

G

Gan	*Galium andrewsii*	H
Gaf	*Galium angustifolium*	Ss
Gap	*Galium aparine*	H
Gax	*Galium* sp.	H, Ss
Gat	*Galium tricorne*	H
Ge	*Garrya elliptica*	S
Gfl	*Garrya flavescens*	S
Gfb	*Garrya flavescens buxifolia*	S
Gfv	*Garrya flavescens venosa*	S
Gf	*Garrya fremontii*	S
Gv	*Garrya veatchii*	Ss
Gh	*Gaultheria humifusa*	S
Gs	*Gaultheria shallon*	Ss
Gd	*Gayophytum diffusum*	H
Gyr	*Gayophytum ramosissimum*	H
Gec	*Gentiana calycosa*	H
Geh	*Gentiana holopetala*	H
Gen	*Gentiana newberryi*	H
Gdi	*Geranium dissectum*	H
Gi	*Geranium incisum*	H
Gem	*Geum macrophyllum*	H
Get	*Geum triflorum*	H
Ga	*Gilia aggregata*	H
Gca	*Gilia capitata*	H
Gcaa	*Gilia capitata achillaefolia*	H
Gig	*Gilia gilioides*	H
Gii	*Gilia inconspicua*	H
Gla	*Gilia latifolia*	H
Gil	*Gilia leptalea*	H
Gim	*Gilia multicaulis*	H
Gx	*Gilia* sp.	H
Gte	*Gilia tenuiflora*	H
Gtr	*Gilia tricolor*	H
Gis	*Githopsis specularioides*	H
Gls	*Glossopetalon spinescens*	Ss
Gll	*Glycyrrhiza lepidota*	H
Gb	*Gnaphalium beneolens*	H
Gnc	*Gnaphalium chilense*	H
Gdc	*Graphalium decurrens californicum*	H
Gra	*Gnaphalium ramosissima*	H
Goam	*Godetia amoena*	H
Goar	*Godetia arcuata*	H
Gbi	*Godetia biloba*	H
Gobo	*Godetia bottae*	H
Godu	*Godetia dudleyana*	H
Goqu	*Godetia quadrivulnera*	H
Gvi	*Godetia viminea*	H
Grs	*Grayia spinosa*	Ss
Gci	*Greeneocharis circumscissa*	H
Grc	*Grindelia camporum*	H
Gcu	*Grindelia cuneifolia*	H
Gro	*Grindelia robusta*	H
Gru	*Grindelia rubricaulis*	H
Guc	*Gutierrezia californica*	Ss
Gl	*Gutierrezia lucida*	S
Gsa	*Gutierrezia sarothrae*	Ss
Gt	*Gymnogramme triangularis*	H

H

Hca	*Haplopappus carthamoides*	H
Hex	*Haplopappus eximius*	H
Hrz	*Haplopappus racemosus*	H
Hac	*Hazardia cana*	Ss
Hs	*Hazardia squarrosa*	Ss
Haw	*Hazardia whitneyi*	Ss
Heb	*Helenium bigelovii*	H
Hho	*Helenium hoopesii*	H
Hpu	*Helenium puberulum*	H
Hsc	*Helianthemum scoparium*	H
Hsv	*Helianthemum scoparium vulgare*	H
Han	*Helianthus annuus*	H
Hec	*Helianthus californicus*	H
Hgr	*Helianthus gracilentus*	H
Hpe	*Helianthus petiolaris*	H
Hlc	*Heliotropium curassavicum*	H
Heco	*Hemizonia congesta*	H
Hco	*Hemizonia corymbosa*	H
Hfa	*Hemizonia fasciculata*	H
Hx	*Hemizonia* sp.	H
Hvg	*Hemizonia virgata*	H
Hvh	*Hemizonia virgata heermannii*	H
Hla	*Heracleum lanatum*	H
Hg	*Heterotheca grandiflora*	H
Hde	*Hibiscus denudatus*	H
Hod	*Hoffmanseggia densiflora*	H
Hop	*Hofmeisteria pluriseta*	H
Hoe	*Holacantha emoryi*	S
Hol	*Hollisteria lanata*	H
Hd	*Holodiscus discolor*	S
Hdd	*Holodiscus discolor dumosus*	S
Hdg	*Holodiscus discolor glabrescens*	S
Hud	*Hugelia densifolia*	H
Hug	*Hugelia virgata*	H
Hvf	*Hugelia virgata floccosa*	H
Huv	*Hulsea vestita*	H
Hyo	*Hydrophyllum occidentale*	H
Hym	*Hymenoclea monogyra*	Ss
Hys	*Hymenoclea salsola*	Ss
Hyf	*Hymenopappus filifolius*	H
Hyc	*Hypericum concinnum*	H
Hfs	*Hypericum formosum scouleri*	H
Hp	*Hypericum perforatum*	H
Hyg	*Hypochoeris glabra*	H
Hyr	*Hypochoeris radicata*	H
Hye	*Hyptis emoryi*	Ss

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[3] This symbol carries overline, i.e., $\bar{X}$.

TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

I

Ird	*Iris douglasiana*	H
Ih	*Iris hartwegii*	H
Ilo	*Iris longipetala*	H
Ima	*Iris macrosiphon*	H
Imi	*Iris missouriensis*	H
Iv	*Isocoma veneta acradenia*	Ss
Iva	*Isocoma veneta arguta*	Ss
Ivv	*Isocoma vencta vernonioidcs*	Ss
Ia	*Isomeris arborea*	Ss
Iax	*Iva axillaris*	H

J

Jac	*Jamesia americana californica*	Ss
Wc	*Juglans californica*	T
Wh	*Juglans hindsii*	T
Jbu	*Juncus bufonius*	H
Jue	*Juncus effusus*	H
Jx	*Juncus* sp.	H
Jc	*Juniperus californica*	T
Ju	*Juniperus californica utahensis*	T
Jm	*Juniperus communis montana*	S
Jo	*Juniperus occidentalis*	T

K

Kpo	*Kalmia polifolia*	S
Kal	*Kalmia polifolia microphylla*	S
Kg	*Kelloggia galioidcs*	H
Ken	*Kentrophyta montana*	H
Koa	*Kochia americana*	H
Koc	*Kochia americana californica*	H
Kra	*Krameria canescens*	Ss

L

Lsc	*Lactuca scariola*	H
Lt	*Larrea tridentata glutinosa*	Ss
Lac	*Lathyrus californicus*	H
Lgr	*Lathyrus graminifolius*	H
Lpo	*Lathyrus polyphyllus*	H
Lsp	*Lathyrus splendens*	H
Las	*Lathyrus strictus*	H
Lav	*Lathyrus vestitus*	H
Laa	*Lavatcra assurgentiflora*	Ss
Lae	*Layia elegans*	H
Lafr	*Layia fremontii*	H
Lag	*Layia glandulosa*	H
Lap	*Layia platyglossa*	H
Lg	*Ledum glandulosum*	S
Lel	*Lepidium lasiocarpum*	H
Ln	*Lepidium nitidum*	H
Lsq	*Lepidospartum squamatum*	Ss
Lef	*Leptodactylon californicum*	Ss
Lpn	*Leptodactylon nuttallii*	H
Lpu	*Leptodactylon pungens*	Ss
Les	*Lessingia leptoclada*	H
Led	*Leucothoe davisiae*	S
Len	*Lewisia nevadensis*	H
Ler	*Lewisia rediviva*	H
I	*Libocedrus decurrens*	T
Lig	*Ligusticum grayi*	H
Lih	*Lilium humboldtii*	H
Lpa	*Lilium pardalinum*	H
Lip	*Lilium parvum*	H
Lir	*Lilium rubescens*	H
Lw	*Lilium washingtonianum*	H
Lma	*Limnanthes alba*	H
Lmd	*Limnanthes douglasii*	H
Lmr	*Limnanthes rosea*	H
Lia	*Linanthus androsaceus*	H
Lau	*Linanthus aureus*	H
Lib	*Linanthus bicolor*	H
Lid	*Linanthus dichotomus*	H
Lif	*Linanthus filipes*	H
Linl	*Linanthus liniflorus*	H
Lim	*Linanthus montanus*	H
Lix	*Linanthus* sp.	H
Lba	*Linnaea borealis amcricana*	H
Lle	*Linum lewisii*	H
T	*Lithocarpus densiflora*	T
Lde	*Lithocarpus densiflora echinoides*	S
Laf	*Lithophragma affinis*	H
Lome	*Lomatium caruifolium*	H
Lomd	*Lomatium dasycarpum*	H
Lomo	*Lomatium mohavense*	H
Lome	*Lomatium nevadense*	H
Lomn	*Lomatium nudicaule*	H
Lomp	*Lomatium piperi*	H
Lps	*Lomatium plummerae sonnei*	H
Lox	*Lomatium* sp.	H
Lout	*Lomatium utriculatum*	H
Lco	*Lonicera conjugialis*	S
Lhc	*Lonicera hispidula californica*	S
Li	*Lonicera interrupta*	S
Lin	*Lonicera involucrata*	S
Lil	*Lonicera involucrata ledebourii*	S
Lsu	*Lonicera subspicata*	S
Lou	*Lonicera utahensis*	S
Lam	*Lotus americanus*	H
Loa	*Lotus argophyllus*	H
Lcr	*Lotus crassifolius*	H
Ldo	*Lotus douglasii*	H
Ldn	*Lotus douglasii nevadensis*	H
Lof	*Lotus formosissimus*	H
Log	*Lotus grandiflorus*	H
Lhu	*Lotus humistratus*	H
Lol	*Lotus leucophyllus*	Ss
Lom	*Lotus micranthus*	H
Lsa	*Lotus salsuginosus*	H
Ls	*Lotus scoparius*	Ss
Lx	*Lotus* sp.	H, Ss
Los	*Lotus stipularis*	Ss
Lst	*Lotus strigosus*	H
Lts	*Lotus subpinnatus*	H
Lal	*Lupinus albicaulis*	H
La	*Lupinus albifrons*	Ss
Lar	*Lupinus arboreus*	Ss

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TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Lbi	*Lupinus bicolor*	H
Lub	*Lupinus breweri*	Ss
Luca	*Lupinus caudatus*	H
Lch	*Lupinus chamissonis*	Ss
Luc	*Lupinus concinnus*	H
Lud	*Lupinus densiflorus*	H
Lux	*Lupinus excubitus*	Ss
Lfo	*Lupinus formosus*	H
Lug	*Lupinus grayi*	H
Lhi	*Lupinus hirsutissimus*	H
Lla	*Lupinus latifolius*	H
Lul	*Lupinus lyallii*	Ss
Lum	*Lupinus micranthus*	H
Lun	*Lupinus nanus*	H
Lnv	*Lupinus nanus vallicola*	H
Luo	*Lupinus odoratus*	H
Lpx	*Lupinus* sp.	H, Ss
Lust	*Lupinus stiversi*	H
Lus	*Lupinus succulentus*	H
Lut	*Lupinus torreyi*	H
Luv	*Lupinus variicolor*	H
Lan	*Lycium andersonii*	Ss
Lca	*Lycium californicum*	Ss
Lyc	*Lycium cooperi*	Ss
Lyf	*Lycium fremontii*	Ss
Lyp	*Lycium pallidum*	Ss
Lto	*Lycium torreyi*	Ss
Ltw	*Lycium torreyi wrightii*	Ss
Lys	*Lygodesmia spinosa*	H
I'	*Lyonothamnus floribundus*	T

M

Mad	*Macronema discoidea*	Ss
Mag	*Macronema greenei*	Ss
Mas	*Macronema suffruticosa*	Ss
Med	*Madia dissitiflora*	H
Mel	*Madia elegans*	H
Mex	*Madia exigua*	H
Mesa	*Madia sativa*	H
Max	*Madia* sp.	H
Mac	*Malacothrix californica*	H
Msa	*Malacothrix saxatilis*	H
Mpa	*Malva parviflora*	H
Mat	*Mamillaria tetrancistra*	Ss
Mv	*Marrubium vulgare*	H
Mav	*Marsilea vestita*	H
Msu	*Matricaria suaveolens*	H
Meap	*Medicago apiculata*	H
Mhi	*Medicago hispida*	H
Mal	*Melilotus alba*	H
Mli	*Melilotus indica*	H
Mes	*Menodora spinescens*	Ss
Mea	*Mentzelia albicaulis*	H
Mdi	*Mentzelia dispersa*	H
Mzl	*Mentzelia laevicaulis*	H
Meli	*Mentzelia lindleyi*	H
Mzm	*Mentzelia micrantha*	H
Mef	*Menziesia ferruginea*	S
Mes	*Mertensia ciliata stomatechoides*	H
Ma	*Mesembryanthemum aequilaterale*	H
Mecr	*Mesembryanthemum crystallinum*	H
Mch	*Micromeria chamissonis*	H
Mic	*Micropus californicus*	H
Map	*Microseris aphantocarpha*	H
Mia	*Microseris attenuata*	H
Mid	*Microseris douglasii*	H
Mcx	*Microseris* sp.	H
Mil	*Militzia glandulifera*	H
Mb	*Mimulus bicolor*	H
Mbo	*Mimulus bolanderi*	H
Mbr	*Mimulus brevipes*	H
Mif	*Mimulus floribundus*	H
Mig	*Mimulus guttatus*	H
Mik	*Mimulus kelloggii*	H
Mle	*Mimulus lewisii*	H
Mm	*Mimulus moschatus*	H
Mix	*Mimulus* sp.	H
Mt	*Mimulus torreyi*	H
Mf	*Mirabilis froebellii*	H
Ml	*Mirabilis laevis*	H
Mod	*Monardella douglasii*	H
Mol	*Monardella lanceolata*	H
Mo	*Monardella odoratissima*	H
Mov	*Monardella villosa*	H
Mog	*Monolopia gracilis*	H
Mom	*Monolopia major*	H
Mpe	*Montia perfoliata*	H
Mc	*Myrica californica*	S
Mh	*Myrica hartwegii*	S

N

Nl	*Nama lobbii*	H
Np	*Nama parryi*	H
Naa	*Navarretia atractyloides*	H
Nac	*Navarretia cotulaefolia*	H
Naf	*Navarretia filicaulis*	H
Nai	*Navarretia intertexta*	H
Nap	*Navarretia pubescens*	H
Nax	*Navarretia* sp.	H
Neh	*Nemophila heterophylla*	H
Nma	*Nemophila maculata*	H
Nem	*Nemophila menziesii*	H
Nep	*Nemophila parviflora*	H
Na	*Nicotiana attenuata*	H
Nbi	*Nicotiana bigelovii*	H
Ng	*Nicotiana glauca*	Ss
Nit	*Nicotiana trigonophylla*	H
Nio	*Nicotiana occidentale*	H
Npa	*Nolina parryi*	Ss
Nyp	*Nymphaea polysepala*	H

O

Oec	*Oenothera contorta*	H
Oed	*Oenothera dentata*	H
Oeh	*Oenothera hookeri*	H
Oeo	*Oenothera ovata*	H
Osc	*Oenothera scapoidea*	H

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TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Oex	*Oenothera* sp. H	Pee	*Pentstemon confertus caeruleo-purpureus* H
Oes	*Oenothera spiralis* H	Peg	*Pentstemon confertus geniculatus* H
Ol	*Olneya tesota* T	Pem	*Pentstemon confertus modestus* H
Oac	*Opuntia acanthocarpa* Ss	Pep	*Pentstemon confertus procerus* H
Oba	*Opuntia basilaris* Ss	Per	*Pentstemon confertus rigidus* H
Ob	*Opuntia bigelovii* S	Pc	*Pentstemon cordifolius* S
Ocl	*Opuntia clavata* Ss	Pcy	*Pentstemon corymbosus* S
Oe	*Opuntia echinocarpa* Ss	Ped	*Pentstemon deustus* H
Ocr	*Opuntia erinacea* Ss	Pef	*Pentstemon fruticiformis* Ss
Oo	*Opuntia occidentalis* Ss	Pgl	*Pentstemon glaber* H
Ooc	*Opuntia occidentalis covillei* Ss	Pgr	*Pentstemon gracilentus* Ss
Ool	*Opuntia occidentalis littoralis* Ss	Ph	*Pentstemon heterophyllus* H
Opa	*Opuntia parryi* Ss	Pja	*Pentstemon jaffrayanus* H
Op	*Opuntia prolifera* Ss	Pela	*Pentstemon labrosus* H
Or	*Opuntia ramosissima* Ss	Pla	*Pentstemon laetus* H
Ox	*Opuntia* sp. Ss	Pcl	*Pentstemon lemmonii* S
Opu	*Opuntia ursina* Ss	Pn	*Pentstemon newberryi* Ss
Ova	*Opuntia vaseyi* Ss	Pepa	*Pentstemon palmeri* Ss
Ora	*Orthocarpus attenuatus* H	Ppa	*Pentstemon parishii* H
Ord	*Orthocarpus densiflorus* H	Prt	*Pentstemon rattanii* H
Ore	*Orthocarpus erianthus* H	Pro	*Pentstemon rothrockii* H
Orl	*Orthocarpus lithospermoides* H	Px	*Pentstemon* sp. H, Ss, S
Opi	*Orthocarpus pilosus* H	Ps	*Pentstemon spectabilis* H
Orp	*Orthocarpus purpurascens* H	Pte	*Pentstemon ternatus* S
Orx	*Orthocarpus* sp. H	Pra	*Peraphyllum ramosissimum* S
Oc	*Osmaronia cerasiformis* S	Pem	*Perezia microcephala* H
Osn	*Osmorrhiza nuda* H	Pet	*Petalonyx thurberi* Ss
Oso	*Osmorrhiza occidentalis* H	Ptp	*Petasites palmata* H
Oxc	*Oxalis corniculata* H	Pes	*Peucephyllum schottii* S
Oxd	*Oxyria digyna* H	Pba	*Phacelia brachyloba* H
		Phca	*Phacelia californica* H
	P	Pdi	*Phacelia distans* H
		Phdo	*Phacelia douglasii* H
Pmy	*Pachystima myrsinites* S	Pfi	*Phacelia fremontii* H
Pbr	*Paeonia brownii* H	Phh	*Phacelia heterophylla* H
Pal	*Palafoxia linearis* H	Phi	*Phacelia hispida* H
Pah	*Papaver heterophyllum* H	Phy	*Phacelia hydrophylloides* H
Pam	*Parkinsonia microphylla* H	Phl	*Phacelia linearis* H
Paf	*Paronychia franciscana* H	Pmi	*Phacelia minor* H
Par	*Parosela arborescens* Ss	Phr	*Phacelia ramosissima* H
Pca	*Parosela californica* Ss	Phx	*Phacelia* sp. H
Pae	*Parosela emoryi* Ss	Ptn	*Phacelia tanacetifolia* H
Pafr	*Parosela fremontii* Ss	Pht	*Phacelia thermalis* H
Pmo	*Parosela mollis* H	Pl	*Philadelphus lewisii californicus* S
Pap	*Parosela parryi* H	Pdo	*Phlox dolichantha* H
Ppo	*Parosela polyadenia* Ss	Phd	*Phlox douglasii* H
Pas	*Parosela spinosa* S	Phg	*Phlox gracilis* H
Pea	*Pedicularis attollens* H	Phs	*Phlox speciosa* H
Pde	*Pedicularis densiflora* H	Pa	*Photinia arbutifolia* S
Peg	*Pedicularis groenlandica* H	Phb	*Phyllodoce breweri* S
Pese	*Pedicularis semibarbata* H	Phe	*Phyllodoce empetriformis* S
Po	*Pellaea ornithopus* H	Pher	*Physalis crassifolia* H
Pex	*Pellaea* sp. H	Phc	*Physocarpus capitatus* S
Pep	*Peltiphyllum peltatum* H	Ws	*Picea breweriana* T
Per	*Pentacaena ramosissima* H	Es	*Picea engelmannii* T
Pac	*Pentstemon acuminatus* H	S′	*Picea sitchensis* T
Pan	*Pentstemon antirrhinoides* S	Pm	*Pickeringia montana* S
Pb	*Pentstemon breviflorus* S	Wp	*Pinus albicaulis* T
Peb	*Pentstemon bridgesii* H	Kp	*Pinus aristata* T
Pce	*Pentstemon centranthifolius* H	Fp	*Pinus balfouriana* T
Pco	*Pentstemon confertus* H	P	*Pinus cembroides monophylla* T

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TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Pp	*Pinus cembroides parryana*	T
Lc	*Pinus contorta*	T
Lb	*Pinus contorta bolanderi*	T
L	*Pinus contorta murrayana*	T
Cp	*Pinus coulteri*	T
Lp	*Pinus flexilis*	T
S	*Pinus lambertiana*	T
W′	*Pinus monticola*	T
Sp	*Pinus muricata*	T
Y	*Pinus ponderosa*	T
J	*Pinus ponderosa jeffreyi*	T
Mp	*Pinus radiata*	T
Dp	*Pinus sabiniana*	T
Tp	*Pinus torreyana*	T
K	*Pinus tuberculata*	T
Pai	*Pirola asarifolia incarnata*	H
Ppi	*Pirola picta*	H
Plg	*Plagiobothrys canescens*	H
Pln	*Plagiobothrys nothofulvus*	H
Plx	*Plagiobothrys* sp.	H
Ple	*Plantago erecta*	H
Plm	*Plantago major*	H
Pma	*Plantago maritima*	H
S[3]	*Platanus racemosa*	T
Plc	*Platystemon californicus*	H
Pci	*Plectritis ciliosa*	H
Plma	*Plectritis macrocera*	H
Plca	*Pluchea camphorata*	H
Pse	*Pluchea sericea*	Ss
Pod	*Pogogyne douglasii*	H
Pose	*Pogogyne serpylloides*	H
Poac	*Polygala acanthoclada*	Ss
Poc	*Polygala cornuta*	H
Pola	*Polygonum acre*	H
Palp	*Polygonum alpinum*	H
Pbs	*Polygonum bistortoides*	H
Pda	*Polygonum davisiae*	H
Pop	*Polygonum paronychia*	H
Psh	*Polygonum shastense*	Ss
Ppx	*Polypodium* sp.	H
Pvk	*Polypodium vulgare kaulfussii*	H
Poa	*Polystichum aculeatum*	H
Pom	*Polystichum munitum*	H
Psx	*Polystichum* sp.	H
F[3]	*Populus fremontii*	T
A[3]	*Populus tremuloides*	T
Ptr	*Populus tremuloides*	S
B[3]	*Populus trichocarpa*	T
Pog	*Porophyllum gracile*	H
Pbi	*Potentilla biennis*	H
Pct	*Potentilla congesta tilingii*	H
Pof	*Potentilla fruticosa*	S
Pogl	*Potentilla glandulosa*	H
Pgo	*Potentilla gordonii*	H
Pogr	*Potentilla gracilis*	H
Plb	*Potentilla lindleyi puberula*	H
Pos	*Potentilla santolinoides*	H
Pox	*Potentilla* sp.	H, S
Prs	*Primula suffrutescens*	H
Pj	*Prosopis juliflora glandulosa*	S
Prp	*Prosopis pubescens*	S
Pad	*Prunus andersonii*	S
Pd	*Prunus demissa*	S
Pe	*Prunus emarginata*	S
Pf	*Prunus fasciculata*	S
Pfr	*Prunus fremontii*	S
Pi	*Prunus ilicifolia*	S
Pi	*Prunus ilicifolia*	T
Psu	*Prunus subcordata*	S
Psa	*Psathyrotes annua*	H
Bs	*Pseudotsuga macrocarpa*	T
D	*Pseudotsuga taxifolia*	T
Psco	*Psilostrophe cooperi*	Ss
Psc	*Psoralea californica*	H
Psm	*Psoralea macrostachya*	H
Pso	*Psoralea orbicularis*	H
Psp	*Psoralea physodes*	H
Pbc	*Ptelea baldwinii crenulata*	S
Pta	*Pteris aquilina lanuginosa*	H
Pg	*Purshia glandulosa*	Ss
Pt	*Purshia tridentata*	Ss
Pyc	*Pycnanthemum californicum*	H
Oa	*Pyrus rivularis*	T

Q

A	*Quercus agrifolia*	T
Qa	*Quercus agrifolia frutescens*	S
C	*Quercus chrysolepis*	T
Qc	*Quercus chrysolepis nana*	S
D′	*Quercus douglasii*	T
Qd	*Quercus dumosa*	S
Qd	*Quercus dumosa*	T
Qdu	*Quercus durata*	S
E	*Quercus engelmannii*	T
Qe	*Quercus engelmannii*	S
G	*Quercus garryana*	T
Qgb	*Quercus garryana breweri*	S
Qgs	*Quercus garryana semota*	S
Qk	*Quercus kelloggii*	S
B	*Quercus kelloggii*	T
V	*Quercus lobata*	T
M′	*Quercus morehus*	T
Qp	*Quercus palmeri*	S
Qs	*Quercus sadleriana*	S
T′	*Quercus tomentella*	T
Qv	*Quercus vaccinifolia*	S
W	*Quercus wislizenii*	T
Qw	*Quercus wislizenii frutescens*	S

R

Ral	*Ranunculus alismaefolius*	H
Rac	*Ranunculus californicus*	H
Rcy	*Ranunculus cymbalaria*	H
Rgl	*Ranunculus glaberrimus*	H
Rale	*Ranunculus lemmonii*	H
Rax	*Ranunculus* sp.	H
Rsa	*Raphanus sativus*	H
Rc	*Rhamnus californica*	S
Rcc	*Rhamnus californica crassifolia*	S

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[3] This symbol carries overline, i.e., $\bar{X}$.

TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Rco	*Rhamnus californica obtusissima*	S
Rcd	*Rhamnus californica occidentalis*	S
Rct	*Rhamnus californica tomentella*	S
Rcr	*Rhamnus crocea*	S
Rci	*Rhamnus crocea ilicifolia*	S
Rcs	*Rhamnus crocea insularis*	S
Rpu	*Rhamnus purshiana*	S
Rru	*Rhamnus rubra*	S
Rri	*Rhodiola rosea integrifolia*	H
Rhc	*Rhododendron californicum*	S
Rho	*Rhododendron occidentalis*	S
Rd	*Rhus diversiloba*	S
Ri	*Rhus integrifolia*	S
Rl	*Rhus laurina*	S
Ro	*Rhus ovata*	S
Rt	*Rhus trilobata*	S
Ram	*Ribes amarum*	S
Ra	*Ribes aureum*	S
Rag	*Ribes aureum gracillimum*	S
Rbi	*Ribes binominatum*	S
Rb	*Ribes bracteosum*	S
Rca	*Ribes californicum*	S
Rh	*Ribes californicum hesperium*	S
Rce	*Ribes cereum*	S
Rdi	*Ribes divaricatum*	S
Rin	*Ribes inerme*	S
Rlc	*Ribes lacustre*	S
Rla	*Ribes laxiflorum*	S
Rll	*Ribes leptanthum lasianthum*	S
Rlo	*Ribes lobbii*	S
Rm	*Ribes malvaceum*	S
Rmi	*Ribes malvaceum indecorum*	S
Rma	*Ribes marshallii*	S
Rme	*Ribes menziesii*	S
Rmo	*Ribes montigenum*	S
Rn	*Ribes nevadense*	S
Rq	*Ribes quercetorum*	S
Rr	*Ribes roezlii*	S
Rrc	*Ribes roezlii cruentum*	S
Rs	*Ribes sanguineum*	S
Rsd	*Ribes sanguineum deductum*	S
Rsg	*Ribes sanguineum glutinosum*	S
Rse	*Ribes sericeum*	S
Rix	*Ribes* sp.	S
Rsp	*Ribes speciosum*	S
Rve	*Ribes velutinum*	S
Rvg	*Ribes velutinum glanduliferum*	S
Rvb	*Ribes viburnifolius*	S
Rvc	*Ribes victoris*	S
Rvi	*Ribes viscosissimum*	S
Rvh	*Ribes viscosissimum hallii*	S
Roc	*Romneya coulteri*	Ss
Rcl	*Rosa californica*	Ss
Rg	*Rosa gymnocarpa*	S
Rom	*Rosa mohavensis*	S
Rnk	*Rosa nutkana*	S
Rop	*Rosa pisocarpa*	S
Rst	*Rosa spithamea*	S
Rle	*Rubus leucodermis*	Ss
Rp	*Rubus parviflorus*	Ss
Rx	*Rubus* sp.	Ss
Rus	*Rubus spectabilis*	Ss
Rv	*Rubus vitifolius*	Ss
Ruc	*Rudbeckia californica*	H
Ruh	*Rudbeckia hirta*	H
Rua	*Rudbeckia acetosella*	H
Rhy	*Rumex hymenosepalus*	H
Rusa	*Rumex salicifolius*	H

S

Sam	*Sabazaria mexicana*	Ss
Sau	*Salicornia ambigua*	H
Slx	*Salicornia* sp.	H
Sas	*Salicornia subterminalis*	H
Xar	*Salix argophylla*	S
Xbr	*Salix breweri*	S
Xc	*Salix commutata*	S
Xcr	*Salix cordata*	S
Xe	*Salix exigua*	S
Xg	*Salix geyeriana argentea*	S
XR	*Salix laevigata*	T
XY	*Salix lasiandra*	T
XA	*Salix lasiolepis*	T
Xl	*Salix lemmonii*	S
Xm	*Salix melanopsis bolanderiana*	S
XB	*Salix nigra vallicola*	T
Xp	*Salix petrophila*	S
Xpm	*Salix phylicifolia monica*	S
Xpi	*Salix piperi*	S
Xs	*Salix scouleriana*	S
Xsh	*Salix sessilifolia hindsiana*	S
Xv	*Salix sitchensis coulteri*	T
Sx	*Salix* sp.	S, T
Skt	*Salsola kali tenuifolia*	H
Sa	*Salvia apiana*	Ss
Scd	*Salvia carduacea*	H
Scr	*Salvia carnosa*	Ss
Sck	*Salvia carnosa compacta*	Ss
Scl	*Salvia clevelandii*	Ss
Sco	*Salvia columbariae*	H
Se	*Salvia eremostachya*	Ss
Sfu	*Salvia funerea*	Ss
Sl	*Salvia leucophylla*	Ss
Sm	*Salvia mellifera*	Ss
Slm	*Salvia mohavensis*	Ss
Spl	*Salvia palmeri*	Ss
Sso	*Salvia sonomensis*	Ss
Ss	*Salvia spathacea*	H
Sg	*Sambucus glauca*	S
Sr	*Sambucus racemosa*	S
Src	*Sambucus racemosa callicarpa*	S
Sv	*Sambucus velutina*	S
Sbi	*Sanicula bipinnatifida*	H
Sme	*Sanicula menziesii*	H
Sax	*Sanicula* sp.	H
Sab	*Sarcobatus baileyi*	Ss
Sav	*Sarcobatus vermiculatus*	Ss
Sat	*Saxifraga tolmiei*	H
Sci	*Scirpus acutus*	H
Scm	*Scirpus microcarpus*	H
Scy	*Scirpus olneyi*	H

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TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Scb	*Scoliopus bigelovii*	H
Scc	*Scrophularia californica*	H
Sfh	*Securinegea fasciculata hallii*	S
Sepu	*Sedella pumilum*	H
Seo	*Sedum obtusatum*	H
Ser	*Sedum radiatum*	H
Sex	*Sedum* sp.	H
Ses	*Sedum spathulifolium*	H
Sd	*Senecio douglasii*	Ss
Sle	*Senecio lugens exaltatus*	H
Sep	*Senecio pauciflorus*	H
St	*Senecio triangularis*	H
Svu	*Senecio vulgaris*	H
Br	*Sequoia gigantea*	T
R	*Sequoia sempervirens*	T
Sha	*Shepherdia argentea*	S
Sih	*Sida hederacea*	H
Sid	*Sidalcea diploscypha*	H
Sigl	*Sidalcea glaucescens*	H
Sim	*Sidalcea malvaeflora*	H
Sdm	*Silene douglasii monantha*	H
Sic	*Silene californica*	H
Sig	*Silene gallica*	H
Sil	*Silene lemmonii*	H
Sca	*Simmondsia californica*	Ss
Sia	*Sisymbrium altissimum*	H
Sii	*Sisymbrium incisum*	H
Sio	*Sisymbrium officinale*	H
Sip	*Sisymbrium pinnatum*	H
Spb	*Sisymbrium pinnatum brachycarpum*	H
Sib	*Sisyrinchium bellum*	H
Sms	*Smilacina sessilifolia*	H
Sn	*Solanum nigrum*	H
Sox	*Solanum* sp.	H, Ss
Su	*Solanum umbelliferum*	Ss
Swa	*Solanum wallacei*	Ss
Sxa	*Solanum xantii*	Ss
Sxg	*Solanum xantii glabrescens*	Ss
Soc	*Solidago californica*	H
Soy	*Solidago corymbosa*	H
Soo	*Solidago occidentalis*	H
Sdx	*Solidago* sp.	H
Ssp	*Solidago spathulata*	H
Sol	*Sonchus oleraceus*	H
Sos	*Sorbus sitchensis*	S
Sc	*Sphacele calycina*	Ss
Spa	*Spaeralcea ambigua*	H
Sda	*Sphaeralcea davidsonii*	H
Sf	*Sphaeralcea fasciculata*	Ss
Srf	*Sphaeralcea fremontii*	S
Sro	*Sphaeralcea rotundifolia*	H
Spca	*Sphenosciadium capitellatum*	H
Spc	*Spiraea caespitosa*	S
Sde	*Spiraea densiflora*	S
Sdu	*Spiraea douglasii*	S
Sbu	*Stachys bullata*	H
Stc	*Stachys californica*	H
Stp	*Stanleya pinnata*	Ss
Sb	*Staphylea bolanderi*	S
Sac	*Statice arctica californica*	S
Stm	*Stellaria media*	H
Stn	*Stellaria nitens*	H
Sli	*Stenotopsis linearifolius*	Ss
Sla	*Stephanomeria lactucina*	H
Str	*Stephanomeria runcinata*	H
Svg	*Stephanomeria virgata*	H
Stl	*Stillingia linearifolia*	H
Sti	*Streptanthus inflatus*	H
Sto	*Streptanthus tortuosus*	H
So	*Styrax officinalis californica*	S
Sof	*Styrax officinalis fulvescens*	S
Suc	*Suaeda californica*	Ss
Sud	*Suaeda depressa*	H
Sum	*Suaeda moquini*	Ss
Sus	*Suaeda suffrutescens*	Ss
Sni	*Swertia nitida*	H
Swr	*Swertia radiata*	H
Sal	*Symphoricarpos albus*	Ss
Syl	*Symphoricarpos longiflorus*	Ss
Smo	*Symphoricarpos mollis*	Ss
Sar	*Symphoricarpos rotundifolius*	Ss
Syx	*Symphoricarpos* sp.	Ss

T

Tag	*Tamarix gallica*	S
Tac	*Tanacetum camphoratum*	H
Tav	*Taraxacum vulgare*	T
U	*Taxus brevifolia*	T
Ted	*Tetracoccus dioicus*	S
Tc	*Tetradymia canescens*	Ss
Tec	*Tetradymia comosa*	Ss
Teg	*Tetradymia glabrata*	Ss
Ts	*Tetradymia spinosa*	Ss
Tst	*Tetradymia stenolepis*	Ss
Thf	*Thalictrum fendleri*	H
Tpo	*Thalictrum polycarpum*	H
Thm	*Thamnosma montana*	Ss
Thfl	*Thelypodium flavescens*	H
Tgv	*Thermopsis gracilis venosa*	H
Tma	*Thermopsis macrophylla*	H
C[2]	*Thuja plicata*	T
Thc	*Thysanocarpus curvipes*	H
Thl	*Thysanocarpus laciniatus*	H
Thx	*Thysanocarpus* sp.	H
Tio	*Tidestromia oblongifolia*	Ss
N	*Torreya californica*	T
Tte	*Tribulus terrestris*	H
Trw	*Tricardia watsonii*	H
Tl	*Trichostema lanatum*	Ss
Tld	*Trichostema lanatum denudatum*	Ss
Tla	*Trichostema lanceolatum*	H
Tlx	*Trichostema laxum*	H
Tx	*Trichostema* sp.	H, Ss
Te	*Trientalis europaea latifolia*	H
Tra	*Trifolium albopurpureum*	H
Tram	*Trifolium amplectens*	H
Tran	*Trifolium andersonii*	H
Trbe	*Trifolium beckwithii*	H
Trb	*Trifolium breweri*	H
Trci	*Trifolium ciliatum*	H
Trde	*Trifolium depauperatum*	H
Trf	*Trifolium fucatum*	H

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[2] This symbol carries underline, i.e., X

TABLE 4—Continued

A. Alphabetical List by Genus of Plants Other Than Grasses—Continued

Trg	*Trifolium gracilentum*	H
Tin	*Trifolium involucratum*	H
Trmc	*Trifolium microcephalum*	H
Trmi	*Trifolium microdon*	H
Trm	*Trifolium monanthum*	H
Trob	*Trifolium obtusiflorum*	H
Tro	*Trifolium olivaceum*	H
Tpr	*Trifolium pratense*	H
Tre	*Trifolium repens*	H
Trx	*Trifolium* sp.	H
Trt	*Trifolium tridentatum*	H
Trv	*Trifolium variegatum*	H
Tov	*Trillium ovatum*	H
Tsg	*Trillium sessile giganteum*	H
Trc	*Trixis californica*	Ss
Tgr	*Tropidocarpum gracile*	H
H	*Tsuga heterophylla*	T
Hм	*Tsuga mertensiana*	T
Tya	*Typha angustifolia*	H
Tyl	*Typha latifolia*	H

U

Ue	*Ulex europaeus*	S
L′	*Umbellularia californica*	T
Uc	*Umbellularia californica*	S
Uli	*Uropappus lincarifolius*	H
Url	*Uropappus lindleyi*	H
Ugh	*Urtica gracilis holosericea*	H

V

Vca	*Vaccinium caespitosum*	S
Vm	*Vaccinium membranaceum*	S
Vmy	*Vaccinium myrtillus*	S
Voc	*Vaccinium occidentale*	S
Vo	*Vaccinium ovatum*	S
Vp	*Vaccinium parvifolium*	S
Vap	*Vancouveria parviflora*	H
Vnc	*Venegasia carpesioides*	H
Vec	*Veratrum californicum*	H
Vev	*Veratrum viride*	H
Vet	*Verbascum thapsus*	H
Vel	*Viburnum ellipticum*	S
Vam	*Vicia americana*	H
Vgi	*Vicia gigantea*	H
Vdp	*Viguiera deltoidea parishii*	Ss
Vl	*Viguiera laciniata*	Ss
Vir	*Viguiera reticulata*	Ss
Vim	*Vinca major*	H
Vu	*Viola adunca*	H
Vbe	*Viola beckwithii*	H
Vib	*Viola blanda*	H
Vic	*Viola cuneata*	H
Vil	*Viola lobata*	H
Vio	*Viola ocellata*	H
Vpe	*Viola pedunculata*	H
Vipr	*Viola praemorsa*	H
Vip	*Viola purpurea*	H
Vis	*Viola sarmentosa*	H
Vc	*Vitis californica*	S
Vg	*Vitis girdiana*	S

W

P[3]	*Washingtonia filifera*	T
Whm	*Whipplea modesta*	S
Whde	*Whitneya dealbata*	H
Wos	*Woodsia scopulina*	H
Wor	*Woodwardia radicans*	H
Wya	*Wyethia angustifolia*	H
Wyg	*Wyethia glabra*	H
Wh	*Wyethia helenioides*	H
Wm	*Wyethia mollis*	H
Wyo	*Wyethia ovata*	H

X

Xt	*Xerophyllum tenax*	H

Y

Yв	*Yucca brevifolia*	T
Ym	*Yucca moharensis*	Ss
Yx	*Yucca* sp.	Ss, T
Yw	*Yucca whipplei*	Ss

Z

Zc	*Zauschneria californica*	H
Zac	*Zauschneria cana*	H
Zl	*Zauschneria latifolia*	H
Zf	*Zygadenus fremontii*	H
Zpa	*Zygadenus paniculatus*	H
Zve	*Zygadenus venenosus*	H

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TABLE 4—Continued

B. Alphabetical List by Genus of Grasses

A

AGc[2]	*Agropyron caninum*
AGd[2]	*Agropyron dasystachyum*
AGpr[2]	*Agropyron pringlei*
AGsm[2]	*Agropyron smithii*
AGx[2]	*Agropyron* sp.
AGs[2]	*Agropyron spicatum*
AGt[2]	*Agropyron tenerum* (*Agropyron pauciflorum*)*
Ae[2]	*Agrostis exarata*
Aha[2]	*Agrostis hallii*
Ah[2]	*Agrostis hiemalis*
Ai[2]	*Agrostis idahoensis*
Ale[2]	*Agrostis lepida*
Ao[2]	*Agrostis oregonensis*
Ap[2]	*Agrostis palustris* (*Agrostis alba*)*
Ar[2]	*Agrostis rossae*
Ax[2]	*Agrostis* sp.
At[2]	*Agrostis thurberiana*
AIc[2]	*Aira caespitosa* (*Deschampsia caespitosa*)*
AId[2]	*Aira danthonioides* (*Deschampsia danthonioides*)*
AIi[2]	*Aira elongata* (*Deschampsia elongata*)*
AIh[2]	*Aira holciformis* (*Deschampsia holciformis*)*
AIx[2]	*Aira* sp. (*Deschampsia* sp.)*
ALa[2]	*Alopecurus aequalis*
ALx[2]	*Alopecurus* sp.
AMa[2]	*Ammophila arenaria*
ADs[2]	*Andropogon saccharoides*
ADx[2]	*Andropogon* sp.
AXo[2]	*Anthoxanthum odoratum*
ASa[2]	*Aristida adscensionis*
ASd[2]	*Aristida divaricata*
ASf[2]	*Aristida fendleriana*
ASo[2]	*Aristida oligantha*
ASpu[2]	*Aristida purpurea*
ASx[2]	*Aristida* sp.
APc[2]	*Aspris caryophyllea* (*Aira caryophyllea*)*
APx[2]	*Aspris* sp. (*Aira* sp.)*
AVb[2]	*Avena barbata*
AVf[2]	*Avena fatua*
AVx[2]	*Avena* sp.

B

BEe[2]	*Beckmannia erucaeformis* (*Beckmannia syzigachne*)*
BEx[2]	*Beckmannia* sp.
BOc[2]	*Bouteloua curtipendula*
BOg[2]	*Bouteloua gracilis*
BOh[2]	*Bouteloua hirsuta*
BOr[2]	*Bouteloua rothrockii*
BOx[2]	*Bouteloua* sp.
BRma[2]	*Briza maxima*
BRm[2]	*Briza minor*
Ba[2]	*Bromus arenarius*
Bb[2]	*Bromus brizaeformis*
Bc[2]	*Bromus carinatus*
Bco[2]	*Bromus commutatus*
Bg[2]	*Bromus grandis*
Bh[2]	*Bromus hordeaceus* (*Bromus mollis*)*
Bl[2]	*Bromus laevipes*
Bma[2]	*Bromus madritensis*
Bm[2]	*Bromus marginatus* (included in *Bromus carinatus*)*
Bo[2]	*Bromus orcuttianus*
Bra[2]	*Bromus racemosus*
Br[2]	*Bromus rigidus*
Bru[2]	*Bromus rubens*
Bse[2]	*Bromus secalinus*
Bx[2]	*Bromus* sp.
Bsu[2]	*Bromus subvelutinus* (*Bromus breviaristatus*)*
Bt[2]	*Bromus tectorum*
Btr[2]	*Bromus trinii*
Bu[2]	*Bromus unioloides* (*Bromus catharticus*)*
Bv[2]	*Bromus vulgaris*

C

CAb[2]	*Calamagrostis breweri*
CAc[2]	*Calamagrostis canadensis*
CAi[2]	*Calamagrostis inexpansa*
CAn[2]	*Calamagrostis nutkaensis*
CAp[2]	*Calamagrostis purpurascens*
CAr[2]	*Calamagrostis rubescens*
CAx[2]	*Calamagrostis* sp.
CEp[2]	*Cenchrus pauciflorus*
CTl[2]	*Chaetochloa lutescens* (*Setaria lutescens*)*
CTx[2]	*Chaetochloa* sp. (*Setaria* sp.)*
CTv[2]	*Chaetochloa viridis* (*Setaria viridis*)*
CHx[2]	*Chloris* sp.
CHv[2]	*Chloris virgata*
CIl[2]	*Cinna latifolia*
CIx[2]	*Cinna* sp.
CYd[2]	*Cynodon dactylon*
CYx[2]	*Cynodon* sp.

D

DCg[2]	*Dactylis glomerata*
Da[2]	*Danthonia americana* (*Danthonia californica americana*)*
Dc[2]	*Danthonia californica*
Di[2]	*Danthonia intermedia*

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* Changes in Nomenclature in Hitchcock's "Manual of the Grasses of the United States."

[2] This symbol carries underline, i.e., X.

TABLE 4—Continued

B. Alphabetical List by Genus of Grasses

Dx[2]	*Danthonia* sp.
Du[2]	*Danthonia unispicata*
DIx[2]	*Distichlis* sp.
DIs[2]	*Distichlis spicata*
DIt[2]	(*Distichlis stricta*)*

E

ECc[2]	*Echinochloa crusgallii*
ECx[2]	*Echinochloa* sp.
Eca[2]	*Elymus canadensis*
Eco[2]	*Elymus condensatus*
Eg[2]	*Elymus glaucus*
Em[2]	*Elymus macounii*
Emo[2]	*Elymus mollis*
Ex[2]	*Elymus* sp.
Et[2]	*Elymus triticoides*
EPr[2]	*Epicampes rigens* (*Muhlenbergia rigens*)*
ERca[2]	*Eragrostis caroliniana* (*Eragrostis pectinacea*)*
ERc[2]	*Eragrostis ciliancnsis*
ERx[2]	*Eragrostis* sp.

F

Fb[2]	*Festuca bromoides* (*Festuca dertonensis*)*
Fca[2]	*Festuca californica*
Fco[2]	*Festuca confinis* (*Festuca kingii*)*
Fc[2]	*Festuca confusa*
Fel[2]	*Festuca elatior*
Fern[2]	*Festuca elmeri*
Fgr[2]	*Festuca grayi*
Fi[2]	*Festuca idahoensis*
Fm[2]	*Festuca megalura*
Fmv[2]	*Festuca myuros*
Fo[2]	*Festuca occidentalis*
Foc[2]	*Festuca octoflora*
Foh[2]	*Festuca octoflora hirtella*
Fp[2]	*Festuca pacifica*
Fre[2]	*Festuca reflexa*
Fr[2]	*Festuca rubra*
Fx[2]	*Festuca* sp.
Fsb[2]	*Festuca subulata*
Fv[2]	*Festuca viridula*

G

Gv[2]	*Gastridium ventricosum*
GLel[2]	*Glyceria clata*
GLp[2]	*Glyceria paueiflora*
GLx[2]	*Glyceria* sp.

H

HIj[2]	*Hilaria jamesii*
HIr[2]	*Hilaria rigida*
HIx[2]	*Hilaria* sp.
HOh[2]	*Holcus halapensis* (*Sorghum halepense*)*
HOx[2]	*Holcus* sp. (*Sorghum* sp.)*
Hg[2]	*Hordeum gussoneanum*
Hj[2]	*Hordeum jubatum*
Hm[2]	*Hordeum murinum*
Hx[2]	*Hordeum* sp.
HYc[2]	*Hystrix californica*
HYx[2]	*Hystrix* sp.

K

Kc[2]	*Koeleria cristata*
Kp[2]	*Koeleria phleoides*
Kx[2]	*Koeleria* sp.

L

LAa[2]	*Lamarckia aurea*
LPf[2]	*Leptochloa filiformis*
LPx[2]	*Leptochloa* sp.
LEc[2]	*Lepturus cylindricus*
Lp[2]	*Lolium perenne*
Lm[2]	*Lolium multiflorum*
Lx[2]	*Lolium* sp.
Lt[2]	*Lolium temulentum*

M

Ma[2]	*Melica aristata*
Mb[2]	*Melica bella* (*Melica bulbosa*)*
Mbu[2]	*Melica bulbosa* (*Melica californica*)*
Mfr[2]	*Melica frutescens*
Mf[2]	*Melica fugax*
Mg[2]	*Melica geyeri*
Mi[2]	*Melica imperfecta*
Mx[2]	*Melica* sp.
Ms[2]	*Melica spectabilis*
Mst[2]	*Melica stricta*
Msb[2]	*Melica subulata*
Mt[2]	*Melica torreyana*
MOl[2]	*Monanthochloe littoralis*
MUf[2]	*Muhlenbergia filiformis*
MUj[2]	*Muhlenbergia jonesii*
MUmo[2]	*Muhlenbergia montana*
MUp[2]	*Muhlenbergia porteri*
MUr[2]	*Muhlenbergia repens*
MUx[2]	*Muhlenbergia* sp.
MUs[2]	*Muhlenbergia squarrosa*

N

NI[2]	*Notholcus lanatus* (*Holcus lanatus*)*
Nx[2]	*Notholcus* sp. (*Holcus* sp.)*

[2] This symbol carries underline, i.e., X.

TABLE 4—Continued

B. Alphabetical List by Genus of Grasses—Continued

O

Oh[2]	*Oryzopsis hymenoides*
Ok[2]	*Oryzopsis kingii*
Ox[2]	*Oryzopsis* sp.

P

PNc[2]	*Panicum capillare*
PNx[2]	*Panicum* sp.
PSd[2]	*Paspalum distichum*
PSx[2]	*Paspalum* sp.
PAa[2]	*Phalaris angusta*
PAr[2]	*Phalaris arundinacea*
PAc[2]	*Phalaris californica*
PAcn[2]	*Phalaris canariensis*
PAm[2]	*Phalaris minor*
PAp[2]	*Phalaris paradoxa*
PAx[2]	*Phalaris* sp.
PHa[2]	*Phleum alpinum*
PHp[2]	*Phleum pratense*
PHx[2]	*Phleum* sp.
POi[2]	*Pholiurus incurvus*
PRo[2]	*Phragmites communis*
PLc[2]	*Pleuropogon californicum*
PLr[2]	*Pleuropogon refractus*
PLx[2]	*Pleuropogon* sp.
Pa[2]	*Poa annua*
Pbv[2]	*Poa biggelovii*
Pbr[2]	*Poa brachyglossa* (*Poa juncifolia*)*
Pc[2]	*Poa compressa*
Pd[2]	*Poa douglasii*
Pf[2]	*Poa fendleriana*
Pg[2]	*Poa gracillima*
Ple[2]	*Poa leibergii*
Pl[2]	*Poa longiligula*
Pn[2]	*Poa nervosa*
Pne[2]	*Poa nevadensis*
Ppa[2]	*Poa palustris*
Pp[2]	*Poa pratensis*
Ps[2]	*Poa sandbergii* (*Poa secunda*)*
Psc[2]	*Poa scabrella*
Px[2]	*Poa* sp.
PYl[2]	*Polypogon lutosus*
PYm[2]	*Polypogon monspeliensis*
PYx[2]	*Polypogon* sp.
PUl[2]	*Puccinellia lemmonii*
PUnu[2]	*Puccinellia nutkaensis*
PUn[2]	*Puccinellia nuttalliana*
PUs[2]	*Puccinellia simplex*
PUx[2]	*Puccinellia* sp.

S

SIh[2]	*Sitanion hanseni*
SIhy[2]	*Sitanion hystrix*
SIj[2]	*Sitanion jubatum*
SIx[2]	*Sitanion* sp.
SPf[2]	*Spartina foliosa*
SOai[2]	*Sporobolus airoides*
SOa[2]	*Sporobolus asperifolius*
SOx[2]	*Sprobolus* sp.
Sc[2]	*Stipa californica*
Scm[2]	*Stipa comata*
Sco[2]	*Stipa coronata*
Se[2]	*Stipa elmeri*
Sle[2]	*Stipa lepida*
Slt[2]	*Stipa lettermanni*
So[2]	*Stipa occidentalis*
Sp[2]	*Stipa pulchra*
Ss[2]	*Stipa speciosa*
Sx[2]	*Stipa* sp.
St[2]	*Stipa thurberiana*
Sv[2]	*Stipa vaseyi*
SYs[2]	*Syntherisma sanguinalis*
SYx[2]	*Syntherisma* sp.

T

TOm[2]	*Torresia macrophylla* (*Hierochloe occidentalis*)*
TRp[2]	*Triodia pulchella*
Tca[2]	*Trisetum canescens*
Tx[2]	*Trisetum* sp.
Ts[2]	*Trisetum spicatum*

[2] This symbol carries underline, i.e., X.

TABLE 4—Continued

C. Supplemental List of Symbols for Plants Other Than Grasses*

A

A	*Quercus agrifolia* T
A[3]	*Populus tremuloides* T

B

B	*Quercus kelloggii* T
B[3]	*Populus trichocarpa* T
B[1]	*Abies venusta* T
Bs	*Pseudotsuga macrocarpa* T
Bt	*Sequoia gigantea* T
By	*Cupressus macnabiana bakeri* T

C

C	*Quercus chrysolepis* T
C[2]	*Thuja plicata* T
Cp	*Pinus coulteri* T

D

D	*Pseudotsuga taxifolia* T
D[3]	*Fraxinus anomala* T
D[1]	*Quercus douglasii* T
Di	*Olneya tesota* T
Dp	*Pinus sabiniana* T
Dy	*Cupressus sargentii duttoni* T

E

E	*Quercus engelmannii* T
Es	*Picea engelmannii* T

F

F[3]	*Populus fremontii* T
Fp	*Pinus balfouriana* T

G

G	*Quercus garryana* T
G[1]	*Abies grandis* T
Gy	*Cupressus goveniana* T

H

H	*Tsuga heterophylla* T
H[2]	*Aesculus californica* T
Hm	*Tsuga mertensiana* T
Hw	*Celtis mississippiensis reticulata* T

I

I	*Libocedrus decurrens* T
I′	*Lyonothamnus floribundus* T

J

J	*Pinus ponderosa jeffreyi* T

K

K	*Pinus tuberculata* T
Kam	*Chenopodium ambrosioides* H
Kca	*Chenopodium californicum* H
Kca	*Chenopodium album* H
Klx	*Cotyledon laxa* H
Kof	*Cotyledon furinosa* H
Kol	*Cotyledon lanceolata* H
Kop	*Cotyledon pulverulenta* H
Kp	*Pinus aristata* T
Ky	*Cupressus nevadensis* T

L

L	*Pinus contorta murrayana* T
L′	*Umbellularia californica* T
Lb	*Pinus contorta bolanderi* T
Lc	*Pinus contorta* T
Lp	*Pinus flexilis* T

M

M	*Arbutus menziesii* T
M[2]	*Acer macrophyllum* T
M′	*Quercus morehus* T
Mp	*Pinus radiata* T
My	*Cupressus macrocarpa* T

N

N	*Torreya californica* T
N[2]	*Acer negundo californicum* T
N[1]	*Abies nobilis* T
Ny	*Cupressus macnabiana* T

O

O	*Chamaecyparis lawsoniana* T
O[3]	*Fraxinus oregona* T
Oa	*Pyrus rivularis* T

* Symbols of plants not occurring in alphabetical sequence in Table 4, B.

[1] This symbol carries accent, i.e., $\hat{X}$.

[2] This symbol carries underline, i.e., $\underline{X}$.

[3] This symbol carries overline, i.e., $\overline{X}$.

TABLE 4—Continued

C. Supplemental List of Symbols for Plants Other Than Grasses—Continued

P

P[3]	*Washingtonia filifera* T
Pv	*Cercidium torreyanum* T
Py	*Cupressus pygmaea* T

Q

Q	*Castanopsis chrysophylla* T
Qkf	*Cucurbita foetidissima* H
Qkp	*Cucurbita palmata* H

R

R	*Sequoia sempervirens* T
R[2]	*Alnus rubra* T
R[1]	*Abies magnifica* T

S

S	*Pinus lambertiana* T
S[3]	*Platanus racemosa* T
S′	*Picea sitchensis* T
S[1]	*Abies magnifica shastensis* T
Sp	*Pinus muricata* T
Sy	*Cupressus sargentii* T

T

T	*Lithocarpus densiflora* T
T′	*Quercus tomentella* T
Th	*Ailanthus glandulosa* T
Tp	*Pinus torreyana* T
Ty	*Cupressus forbesii* T

U

U	*Taxus brevifolia* T
Ux	*Euphorbia* sp. H, Ss

V

V	*Quercus lobata* T
V[3]	*Fraxinus velutina* T

W

W	*Quercus wislizenii* T
W′	*Pinus monticola* T
W[1]	*Abies concolor* T
Wc	*Juglans californica* T
Wh	*Juglans hindsii* T
Wp	*Pinus albicaulis* T
Ws	*Picea breweriana* T

X

Xa	*Salix lasiolepis* T
Xar	*Salix argophylla* S
Xb	*Salix nigra vallicola* T
Xbr	*Salix breweri* S
Xc	*Salix commutata* S
Xcr	*Salix cordata* S
Xe	*Salix exigua* S
Xg	*Salix geyeriana argentea* S
Xl	*Salix lemmonii* S
Xm	*Salix melanopsis bolanderiana* S
Xp	*Salix petrophila* S
Xpi	*Salix piperi* S
Xpm	*Salix phylicifolia monica* S
Xr	*Salix laevigata* T
Xs	*Salix scouleriana* S
Xsh	*Salix sessilifolia hindsiana* S
Xv	*Salix sitchensis coulteri* T
Xy	*Salix lasiandra* T

Y

Y	*Pinus ponderosa* T

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[1] This symbol carries accent, i.e., $\hat{X}$.

[2] This symbol carries underline, i.e., $\underline{X}$.

[3] This symbol carries overline, i.e., $\overline{X}$.

CASTLE LAKE TROUT INVESTIGATION 1946 CATCH, AND CHEMICAL REMOVAL OF ALL FISH[1]

By J. H. Wales

Bureau of Fish Conservation, California Division of Fish and Game

Castle Lake is a fairly typical Northern California lake. It has an area of 47 acres, and is located near Mt. Shasta, Siskiyou County. An intensive investigation has been made of this lake since 1938, and a creel census has been conducted since 1941. The objectives of the investigation were to determine the most suitable species of trout for lakes of this type, and the optimum number and size to plant. The lake contained small self-maintaining populations of mackinaw trout and minnows, but afforded no facilities for significant natural reproduction of rainbow, brook or brown trout, the principal species produced in our hatcheries. It was therefore decided to stock equal numbers of each of these species annually to determine the one best suited to conditions, and later to concentrate on that one to determine the size and numbers to be planted to produce the optimum catch.

The results of the first five years of the census, 1941 to 1945 inclusive, were published in July, 1946 (Wales, 1946). During that period the brown had been the dominant species, providing approximately half of the total catch in numbers, and far more than half in weight. However, there was reason to believe that, while the brown trout might provide the bulk of the fishing when planted together with the other two species, either one of the other two might provide better fishing if planted alone. It was, therefore, decided to begin the second phase of the program, planting one species only, and since brook trout are used in many parts of the State for lakes of this type, this species was selected.

It was realized that, if we merely refrained from planting anything but brook trout in Castle Lake, the brown trout, because of their longevity, would continue for years to be a complicating factor. It was therefore decided to eliminate all fish by "poisoning" (i.e., treatment of the lake with rotenone) in order to get a fresh start, and it was hoped at the same time that we might make a sufficiently complete recovery of the fish killed to get a good idea of the total population in the lake.

The present report gives the data on the anglers' catch in 1946, and on the destruction of all fish in the lake by rotenone in October, 1946, thus concluding the "First phase" of the investigation. The lake, at date of writing this, still contained so much rotenone at 30 feet depth and below as to be lethal to trout. Upon recovery, it will be stocked with 20,000 brook trout, thus initiating the "Second phase" of the investigation, in which a single species of trout will occupy the lake.

[1] Submitted for publication June, 1947.

TABLE 1

Record of Fish Planted in Castle Lake

Date	Number and species	Size,* number, per oz.	Fin mark†
1938			
October 21	7,000 rainbow	9.2 per oz.	Ad.
October 21	7,000 brown	6.5 per oz.	Ad.
October 21	25,000 brook	21.0 per oz.	Not marked
1939			
September 20	6,360 rainbow	7.0 per oz.	L. V.
September 20	7,000 brown	9.5 per oz.	L. V.
August 5	7,000 brook	6.0 per oz.	R. V. & Ad.
1940			
September 9	7,305 rainbow	5.0 per oz.	R. V.
September 10	7,500 brown	9.0 per oz.	R. V.
August 20	7,000 brook	6.0 per oz.	L. V.
1941			
August 29	7,000 rainbow	7.0 per oz.	L. V. & Ad.
September 18	7,000 brown	12.0 per oz.	L. V. & Ad.
August 13	7,101 brook	8.0 per oz.	R. V. & Ad.
1942			
June 11	15,000 rainbow	37.0 per oz.	Not marked
June 11	15,000 brown	31.0 per oz.	Not marked
June 11	15,000 brook	34.0 per oz.	Not marked
June 11	2,000 rainbow	1.4 per oz.	2 V.
June 11	181 rainbow	1.1 oz. each.	2 V. & Ad.
June 11	1,640 brown	1.0 per oz.	2 V.
June 11	173 brown	1.5 per oz.	2 V. & Ad.
June 11	181 brook	2.7 oz. each	2 V. & Ad.
1943			
August 2	5,000 rainbow	17.0 per oz.	Ad.
August 2	5,000 brown	25.0 per oz.	Ad.
July 29	5,000 brook	14.2 per oz.	Ad.
May 27	900 rainbow	11.0 per lb.	R. V. & Ad.
May 27	900 brown	10.6 per lb.	R. V. & Ad.
May 27	900 brook	9.8 per lb.	R. V. & Ad.
May 6-7	148 rainbow	1.4 lbs. av.	½ D. & Ad.
May 6-7	75 rainbow	5.0 lbs. av.	½ D. & Ad.
1944			
July 29	7,000 rainbow	10.9 per oz.	L. V.
August 15	7,000 brown	20.8 per oz.	L. V.
July 29	7,000 brook	12.0 per oz.	L. V.
1945			
July 20	3,500 rainbow	9.6 per oz.	Not marked
July 20	3,500 rainbow	9.3 per oz.	R. V.
August 16	6,000 brown	14.8 per oz.	R. V.
July 20	7,000 brook	12.9 per oz.	R. V.
1946			
June 3	2,000 book	1.0 per oz.	Ad.

* Average lengths of fish are approximately:
1½″ at 35 per ounce
1¾″ at 25 per ounce
2″ at 15 per ounce
3″ at 5 per ounce
5″ at 1 per ounce

† Ad. = Adipose
L. V. = Left Ventral
R. V. = Right Ventral
2 V. = Both Ventrals

Fingerlings planted in 1946 for survival tests are not shown.

TABLE 2

Angling Data by Months, 1946

Month	Number of Angler days	Man-hours fished	Average hours per angler day	Number of fish recorded					Average catch		Zero catches	
				EB	RT	BN	MACK	Total	Per angler	Per hour	Number	Percent
May	74	224	3.3	52	37	76	6	171	2.3	0.77	41	55
June	163	695	4.2	178	50	281	10	519	3.2	0.75	66	40
July	210	957	4.5	78	66	122	1	267	1.2	0.28	132	63
August	151	608	4.2	60	23	13	21	117	0.8	0.19	125	83
September	63	176	2.8	75	45	57	0	177	2.8	1.00	18	29
October	6	14	2.2	11	0	13	0	25	4.0	1.70	1	16
Totals	667	2,674	4.0	454	221	562	38	1,275	1.9	0.48	383	57

Summary of Pertinent Facts

Physical Data

Castle Lake, Siskiyou County, California, T. 39 N., R. 5 W., S. 13.
Tributary to the Sacramento River via Castle Lake Creek.
Geological character: Granitic, glacial cirque.
Elevation: 5,200 feet.
Surface area: 47 acres.
Volume: Approximately 1,800 acre-feet.
Maximum depth: 120 feet. (This is in the south part of the lake; the northern third is a shallow basin not over 15 feet deep.)
Temperature range: 32°-75° F.
Tributaries to Castle Lake: Seasonal; water from melting snow.

Fish Present in Castle Lake

The following species of fish were present at time of treatment with rotenone (October 9, 1946):

1. Brown trout—*salmo trutta* Linné.
2. Shasta Rainbow trout—*Salmo gairdnerii stonei* Jordan.
3. Eastern Brook trout—*Salvelinus fontinalis* (Mitchill).
4. Mackinaw trout—*Cristivomer namaycush namaycush* (Walbaum).
5. Western Golden Shiner—*Notemigonus crysoleucus auratus* (Rafinesque).
6. Black Dace—*Rhinichthys osculus* (Girard).

Anglers' Catch in 1946

The anglers' catch in 1946 is shown in Table 2.

The picture in 1946, insofar as distribution by species goes, was distorted by the fact that 2,000 eastern brook trout, averaging one ounce each, were planted early (June 3d) to improve fishing during the season. Had it not been for this addition of catchable fish, angling would have been much poorer than it was. Of this eastern brook plant, 293 were caught before the lake was poisoned. The distribution by species, with these 293 brooks included, and with them excluded, is shown in Table 3.

TABLE 3

Catch Distribution by Species, 1946

(1) Species	(2) All fish	(3) Not counting 1946 plant of E B yearlings
Brown	562 (44%)	562 (57%)
Rainbow	221 (17%)	221 (22%)
Eastern brook	454 (36%)	161 (17%)
Mackinaw	38 (3%)	38 (4%)
Totals	1,275	982

The picture in Column 3 above resembles much more closely the preceding years—with the exception of 1943, when there were abnormal plantings of large rainbow — than that in Column 2 (Compare with Table 4).

The fishing in 1946 was notably poorer in total and in catch per hour, than in any previous year except 1941 (See Table 4). Even the yield of the one-ounce brook trout planted in 1946 (293 out of 2,000 or 14.6 percent) was far below the yield of the 900 brooks planted in 1943 at a size of 10 per pound (196 were caught in 1943, or 22 percent—see Table 9),

TABLE 4

Summary of Angling Data, 1941-1946, Inclusive

	1941	1942	1943	1944	1945	1946
Fishing season—days	137	155	184	184	184	161
Number angler days	548	555	546	769	489	667
Total catch	730	1,332	2,136	1,867	1,588	1,275
Average catch per day	1.33	2.40	3.91	2.57	3.25	1.90
Average hours fished	3.5	5.3	4.0	3.1	3.4	4.0
Average catch per hour	0.38	0.45	0.98	0.79	0.95	0.48
Brown trout caught	368 (50%)	612 (46%)	728 (34%)	1,101 (59%)	797 (51%)	562 (44%)
Rainbow trout caught	175 (24%)	427 (32%)	1,151 (53%)	399 (21%)	487 (31%)	221 (17%)
Eastern Brook trout caught	176 (24%)	252 (19%)	258 (12%)	241 (13%)	224 (14%)	454 (36%)
Mackinaw trout caught	11 (2%)	39 (3%)	11 (.5%)	126 (7%	53 (3%	38 (3%)
Unclassified trout		2			27 (1%)	
Total catch	730	1,332	2,148	1,867	1,588	1,275

although the angling pressure was lower in the earlier year (546 angler-days in 1943, as against 667 in 1946). No explanation has been found for the poor fishing in 1946.

TABLE 5

Number of Angler-Days and Individual Anglers

	Angler days	Individual anglers
1942	555	334
1943	546	227
1944	769	170
1945	489	140
1946	667	407

The proportional increase of "individual anglers" to "angler days" in 1946 may be due to poor fishing which would reduce repeaters, while at the same time increased travel brought in more anglers from a distance.

Distribution of Fish Among the Fishermen

1943 ..... 15 anglers caught over 50 percent of the total catch
1944 ..... 10 anglers caught over 50 percent of the total catch
1945 ..... 13 anglers caught over 50 percent of the total catch
1946 ..... 20 anglers caught over 50 percent of the total catch

Distribution of Catch According to Lure Used

	1943 Percent	1944 Percent	1945 Percent	1946 Percent
Spinner	45	55	51	34
Bait	39	19	29	48
Fly	16	26	20	18

Removal of Fish From Castle Lake

Reasons for Poisoning

It was pointed out in the report of the "Castle Lake Trout Investigation, First Phase" that the mixture of four species of trout in Castle Lake is not a productive combination, and that one species alone would probably yield more satisfactory fishing. Rather than waste the years which it would take, even though planting were confined to brook trout only, for the rainbow and especially the browns to die or be caught out, and be left even then with the mackinaws, which are found only in three other waters in the State, it was decided to poison the lake and restock with brook trout. A further reason for poisoning was the hope that we could thus enumerate the fish population remaining in the lake at the end of the season. In addition, the idea was conceived of planting fingerlings at intervals of two months, one month, and two weeks prior to poisoning, and obtaining from the recaptures survival figures on small trout in the critical early days after planting.

Method of Poisoning

The volume of Castle Lake was estimated from its surface area and numerous soundings to be about 1,800 acre-feet. A very considerable area of the bottom is 100 feet or more deep. Preceding the poisoning operations the lake was marked off by rows of buoys. These aided in making

accurate soundings of the lake and also helped the workers in distributing the poison evenly. The poison used was Cube powder with a 5.4 percent rotenone content.

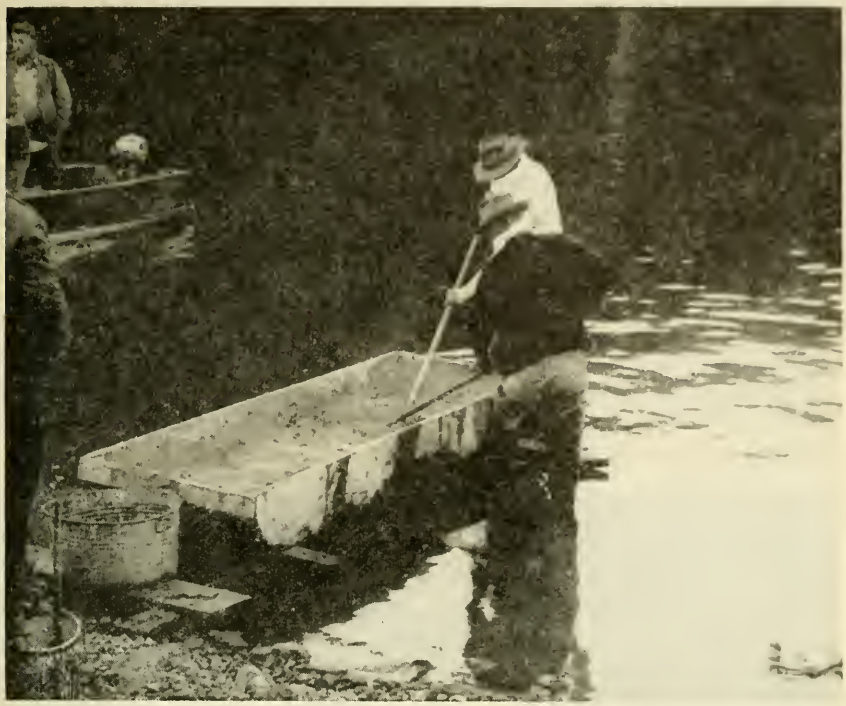

FIGURE 127. Mixing cube powder with water during chemical treatment of Castle Lake

The actual poisoning work began early on the morning of October 9, 1946, and continued all that day and part of the next. Water temperature was about 58 degrees F. at surface, 42 degrees F. at 100 feet. About 15 men and five boats with outboard motors took part in the operation. The powder was mixed on shore in a concrete mixing boat, then taken to the distributors by a tender. Four methods of distribution were employed:

1. The shore line was covered simply by broadcasting with dippers.
2. The shallow areas were covered by pouring the poison liquid behind an outboard motor.
3. Depths from 10 to 50 feet were poisoned by a siphon method which will be described.
4. Depths between 50 and 120 feet were reached by a gasoline engine and centrifugal pump connected to a weighted garden hose.

The siphon method mentioned above was developed by Harold H. Hewitt of the California Division of Fish and Game. After computing the volume of water in a stratum and the amount of poison needed, a wash tub or other large receptacle is set upon supports extending from gunwale to gunwale of the boat. Thus, the poison liquid is raised about

18 inches above the surface of the lake. Next, a three-quarter inch garden hose is filled with water and started siphoning out of the tub. The length of the hose depends upon the depth of the stratum to be poisoned. Several 25-feet lengths can be coupled to give any desired length. Any heavy object can be fastened to one end of the hose or the hose can be coupled to a length of pipe to give the weight necessary to keep it down. The other end of the hose can be fastened into the tub of poison liquid. The liquid is siphoned out quite rapidly, and the amount distributed can be regulated by the speed of the boat. This is the simplest and most accurate method of distribution that the writer has used or heard of.

Those who assisted in the poisoning were largely members of the California Division of Fish and Game, but able assistance was rendered by members of the U. S. Forest Service, and by local fishermen.

Results of Poisoning

The operations on October 9th killed almost all fish on that day. Of the four species of trout and the two species of minnows in the lake, there was little apparent difference in the reaction to the poison, except that the large golden shiners were the last to be killed, and a few were still swimming feebly on the 10th. After that date no fish life could be found, and destruction of fish was complete.

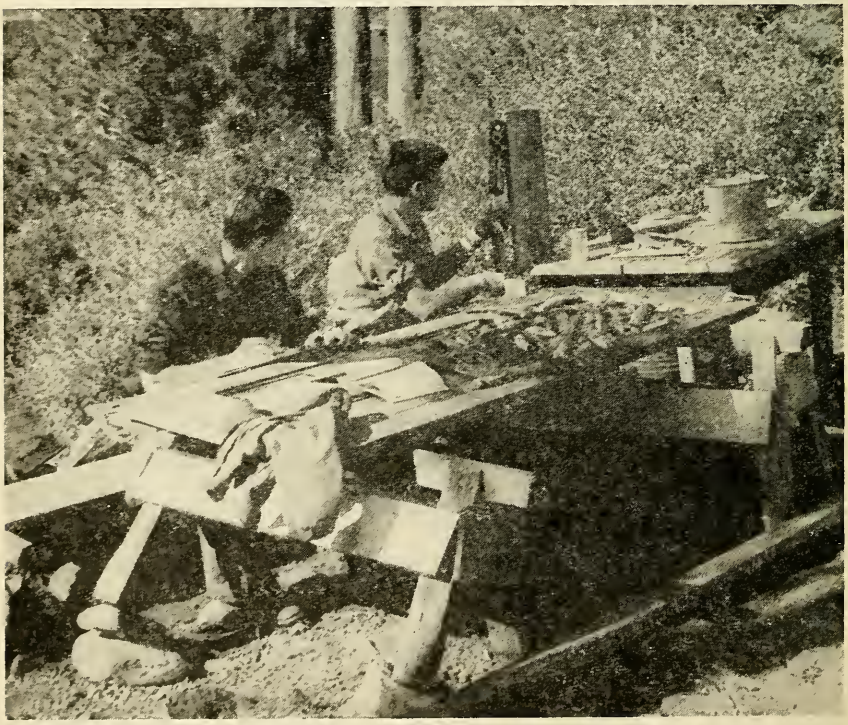

FIGURE 128. Recording fish recovered after chemical treatment of Castle Lake on October 9, 1946

Ordinarily it is unnecessary to collect the poisoned fish in any body of water being treated, in fact, it is desirable to let the fish decompose and fertilize the water. However, in Castle Lake we did not want to waste the large number of edible trout, and we wanted to get as complete a census of the population as possible. Therefore, the poisoning project was advertised, and about 300 people and 25 boats were on hand to take part in the collection of the fish. All participants were required to bring the poisoned fish which they captured to a central point, where a record was made of the species, mark, length, and also in many cases, the weight. After this, each person was allowed to retain one limit, and the remaining fish were preserved.

Naturally many fish sank into deep water and could not be recovered. The writer feels that not over half of them were picked up, but this is only a rough estimate. The numbers by species, of those actually collected, are given below:

TABLE 6

Fish Recovered After Rotenone Treatment, Not Including Fingerlings Planted in 1946

Species	Number recovered
Brown trout	2,027
Brook trout (Planted prior to 1946)	50
Brook trout (2,000 yearlings planted 6–3–46 at 1 per oz	364
Mackinaw trout	81
Rainbow trout	44
Black dace	Several thousand
Golden shiners	Several hundred

The large number of brown trout as compared to other species is most striking. There is reason to believe that this is not a true picture of the distribution by species of the lake population at time of poisoning. Tables 8, 9, and 10 throw light on this matter and provide other revealing information. These tables give, by species, the number of poisoned trout recovered on and after October 9, 1946, broken down into the several year-classes present; and also the anglers' catch records for the past six years; thus showing all of the fish which can be accounted for, both caught and poisoned.

For the purposes of illustration, some of the data on rainbow from Table 8 are regrouped below to show the pattern of survival:

TABLE 7

(1) Year class*	(2) Number caught by anglers in first season after year of planting	(3) Number caught by anglers in second season after year of of planting	(4) Ratio of Col. 3 to Col. 2
1940	135	80	80/135 59%
1941	61	89	89/61 146%
1943	86	29	29/86 34%
1944	406	69	69/406 17%
1945	136	--	------ -----

* The 1942 year-class is omitted because the fish were so small at planting as to preclude comparison—37 per ounce as compared to 10 per ounce average for the classes shown above.

TABLE 8

RAINBOW

Summary of Fish Caught by Anglers and Recovered From Poisoning (Not Including Fingerlings Planted in 1946)

Year	Planted		Caught									Total of fish caught by angling and those poisoned and recovered	
	Number	Size-(Number per oz.)	1941	1942	1943	1944	1945	1946	Total	Percent caught	Number of poisoned fish recovered	Number	Percent
1938	7,000	9.2	34	12	7	8	0	0	61			61	
1939	6,360	7.0	6	19	3	3	1	0	32	0.5		32	0.5
1940	7,305	5.0	135	80	29	4	3	1	252	3.4		252	3.4
1941	7,000	7.0		61	89	27	4	0	181	2.6		181	2.6
1942	15,000	37.0			467	140	27	3	637	4.2	1	638	4.3
1943	5,000	17.0				86	29	6	121	2.4	1	122	2.5
1944	7,000	10.0				32	406	69	507	7.2	11	518	7.4
1945	7,000	9.6						136	136	1.9	31	167	2.4
	Yearlings	Per pound											
1942	2,180	16-24		239	191	42	4	0	476	21.8		476	21.8
1943	900	11.0			299	49	4	6	358	39.1		358	39.8
	Adults	Lbs. each											
1943	223	1.4 av. and 5.0 av.			69	2	0	0	71	31.9		71	31.9

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TABLE 9

BROOK TROUT

Summary of Fish Caught by Anglers and Recovered From Poisoning (Not Including Fingerlings Planted in 1946)

Year	Planted		Caught									Total of fish caught by angling and those poisoned and recovered	
	Number	Size-(Number per oz.)	1941	1942	1943	1944	1945	1946	Total	Percent caught	Number of poisoned fish recovered	Number	Percent
1939	7,000	6.0	15	1	0	0	0	0	16			16	
1940	7,000	6.0	152	58	4	1	0	0	215	3.1		215	3.1
1941	7,010	8.0		118	18	1	0	0	137	2.0		137	2.0
1942	15,000	34.0			21	66	13	2	102	0.7		102	0.7
1943	5,000	14.2				14	7	0	21	0.4	4	25	0.5
1944	7,000	12.0				2	181	138	321	4.6	19	340	4.9
1945	7,000	12.9					0	21	21	0.3	26	47	0.7
	Yearlings	Per pound											
1942	181	6		57	11	1	0	0	69	38.1	0	69	38.1
1943	900	10			196	149	12	0	357	39.7	1	358	39.8
1946	2,000	16						293	293	14.6	364	657	32.8

TABLE 10

BROWN TROUT

Summary of Fish Caught by Anglers and Recovered From Poisoning

Year	Planted		Caught									Total of fish caught by angling and those poisoned and recovered	
	Number	Size-(Number per oz.)	1941	1942	1943	1944	1945	1946	Total	Percent	Number of poisoned fish recovered	Number	Percent
1938	7,000	6.5	90	67	44	18	4	0	223	3.2	3	226	3.2
1939	7,000	9.5	80	129	54	71	33	10	377	5.2	28	405	5.8
1940	7,500	9.0	27	245	133	139	103	49	696	9.3	87	783	10.4
1941	7,000	12.0	----------	5	106	120	74	35	340	4.9	67	407	5.8
1942	15,000	31.0	----------	----------	92	371	267	174	904	6.0	317	1,221	8.1
1943	5,000	25.0	----------	----------	----------	22	85	8	115	2.3	159	274	5.5
1944	7,000	20.8	----------	----------	----------	----------	73	170	243	3.5	710	953	13.6
1945	6,000	14.8	----------	----------	----------	----------	----------	14	14	----------	589	603	10.1
Unclassified	----------	----------	----------	----------	----------	----------	----------	56	56	----------	----------	56	----------
	Yearlings												
1942	1,800	1–1.5 per oz.	----------	85	223	161	66	24	559	30.0	43	602	33.4
1943	900	10.6 per lb.	----------	----------	51	165	68	22	306	31.6	24	330	36.6

There are no figures for the 1945 year-class in Column 3 above because that would be the catch of the 1947 season. In their place, we do have the number of rainbows of this year-class recovered after poisoning, 31. If *all* of these 31 fish were to have survived through the winter, and if *all* of them were to have been caught in the 1947 season, the figure in Column 3 for the 1945 year-class would be 31, and the figures in Column 4 would be 31/136, or 23 percent. Even this would be far below the average of the percentages for the other year-classes; and of course survival through the winter of 100 percent of the population is not possible, and catch by anglers of 100 percent of the population is recognized to be very far from what actually occurs. In other words, there must have been many times 31 rainbow trout of the 1945 year-class left in Castle Lake on October 9, 1946, unless its mortality pattern were completely different from the year-classes which preceded it.

A direct comparison can be made with the eastern brook as shown in Table 9. The way in which the two species make their contribution to the catch is well shown in Tables 8 and 9. For the brook, the bulk of the catch of any year-class (excepting 1942, planted at an unusually small size) is made the year after planting, with very little left thereafter. For the rainbow, while the bulk of the catch is made the year after planting, there remains a residual which makes a significant contribution to the catch the succeeding season. According to this pattern, recovery of poisoned rainbow of the 1945 year-class should have been much greater, in comparison to the catch in 1946, than of eastern brook, in comparison to the catch of this species, yet the reverse was true: 26 brooks were recovered against 21 caught, whereas only 31 rainbow were recovered against 136 caught.

Everything seems to indicate that the number of rainbow recovered after poisoning fell far short of being as large a proportion of the total number present as was the case for the other two species. One reason for this may be found in the feeding habits. Stomach analyses have shown the rainbows to be extensive plankton feeders in Castle Lake, and in past summers they have been commonly seen feeding on plankton near the surface

TABLE 11

Relationship of Anglers' Catch in 1946 to Fish Recovered at End of Season

	Anglers' catch in the 1946 season	Fish recovered on October 9, 1946
Brown trout	562	2,027
Brook trout (planted prior to 1946)	161	50
Brook trout (yearlings planted in 1946)	293	364
Rainbow trout	221	44
Mackinaw trout	38	81
Totals	1,275	2,566

over the deepest portion of the lake. Such fish when poisoned would probably sink in deep water, and could not be recovered. The brook trout are apparently much smaller consumers of plankton after their first year than the rainbow, and are commonly found near shore; the brown trout take very little plankton at any age (See Wales, 1946, Tables 11 and 12).

It has been pointed out earlier in this report that the number of fish recovered on October 9th is an unknown fraction of the fish present at that time. This fraction was roughly estimated at one-half, but it may be considerably less. Also, it has been pointed out that the proportions of the species recovered are probably different from the actual proportions present on October 9th, and that undoubtedly, there were proportionally more rainbow than are shown in the foregoing figures.

However, there is no question but that the brown trout in the lake at time of poisoning far outnumbered the other species. This derives from the fact, brought out in Tables 8, 9, and 10, that while the brooks make the greatest contribution to the catch in the year following that in which they were planted as fingerlings and then almost disappear, and that while the rainbows continue to make a showing in the catch for one or two more years, the browns do not begin to appear in significant numbers in the catch until the second year after planting, and thereafter continue to play an important part for several years. The result is that they build up a backlog, and eventually, in lakes where they are planted with the other two species, come to form the bulk of the population of catchable fish. The same phenomenon has been noted in Frog Lake in Nevada County: Planted in equal numbers with brooks and rainbows from 1938 through 1942, the browns were discontinued in 1943, in which year, and thereafter, rainbows only were planted; and yet, in 1946, the browns still formed 58 percent of the total catch.

One of the most striking facts brought out by the figures in Table 11 is the large number of fish present in a lake where fishing could not be called good. Angling in Castle Lake in 1946, with a catch of less than one-half of one fish per hour, could not be called good, by comparison with other waters or with its own past record. And yet at the end of the season, there were still at least twice as many fish of catchable size in the lake as had been caught (and probably many more, in view of the number which escaped recovery and therefore were not included in the count); and of brown trout there were over four times as many as were caught.

We have here a demonstration that even after a season of heavy angling and poor success, there may well be plenty of fish left in a lake to provide an ample spawning stock. If Castle Lake had spawning areas for all trout present; if one-half of all mature trout were females; if each female produced only 300 eggs (and the average based on size ranges shown in Table 14 would probably be higher); and if only the fish recovered on October 9, 1946, took part in the spawning (and we have every reason to believe that the number present was actually far greater than the recoveries, especially in the rainbow); then the natural production of eggs in the fall and spring spawnings of 1946-47 would be:

Brown trout, approximately	300,000
Brook trout, approximately	60,000
Rainbow trout, approximately	6,600
Total	366,600

As against this, we have been planting around 20,000 advanced fingerlings annually, or as high as 45,000 fingerlings at 31 to 37 per ounce ($1\frac{1}{2}$ to $1\frac{3}{4}$ inches). If Castle Lake had spawning tributaries, the natural

production would have been so great, even allowing for egg and fry mortality, that the hatchery additions would have had no effect other than to increase competition, and thus to decrease survival and growth of the natural fish.

Castle Lake has no tributaries, and must be stocked to maintain fishing. But in lakes which do have sufficient spawning areas, it seems probable that, even when they appear to be "fished out" and there is a demand for planting of hatchery fingerlings, there is often a brood stock left sufficiently numerous to produce so many young trout that additions from the hatchery are of no value, and may be harmful.

TABLE 12

Recovery of Fingerlings Planted in 1946 Prior to Poisoning

Species	Number	Size	Date planted	Number days in lake	Recovered	
					Number	Percent
Rainbow	1,500	8.3	8/14/46	55	50	3.3%
Eastern Brook	1,500	10.0	8/14/46	55	96	6.4%
Rainbow	1,000	6.9	9/ 9/46	29	219	21.9%
Eastern Brook	1,000	7.1	9/ 9/46	29	268	26.8%
Rainbow	500	6.0	9/24/46	14	152	30.4%
Eastern Brook	500	5.3	9/24/46	14	218	43.6%

Survival of Fingerlings Planted in 1946

Table 12 gives recoveries of the rainbow and brook trout which were planted at intervals within two months of the time of poisoning to furnish data on fingering survival. As would be expected, the longer the fish had been in the lake, the lower the recovery. Predation is undoubtedly very heavy during the fingerling stage, but heretofore we had little idea of the extent of this loss. Of course it should be pointed out that the number recovered is only a part of the number actually present in the lake at poisoning time.

Plotting the data from Table 12 on a semi-logarithmic scale (Fig. 129) indicates a discrepancy in the mortality rates of the groups planted at the three different times. For both rainbows and brooks, the survival of the 55-day groups is below what would be expected from survival of the 14-day and 29-day groups. The possibility that mortality occurs at a higher rate after the first month in the water than prior thereto, is most unlikely. There is a possibility that the 55-day groups had a higher mortality in their first days in the lake than the later groups; but a more likely explanation is the probable greater dispersal of the earlier group. The earlier plant had much more opportunity to become accustomed to natural conditions prior to poisoning. They may well have moved into deeper or more inaccessible areas where they would sink out of sight or fail to be observed when poisoned, whereas the fingerlings which had been in the lake only a short time were still near shore, in shallow water, and could be more easily recovered. It is noteworthy that the recovery of brook trout fingerlings was in all cases higher than of comparable lots of rainbow. In contrast, the anglers' catches show a lower survival of

brooks than of rainbows in Castle Lake. Here may be another example of the already mentioned difference in habit: The shore-loving nature of the brooks in contrast to the tendency of the rainbows to live more in parts of the lake far from shore. It is also noteworthy that the recovery

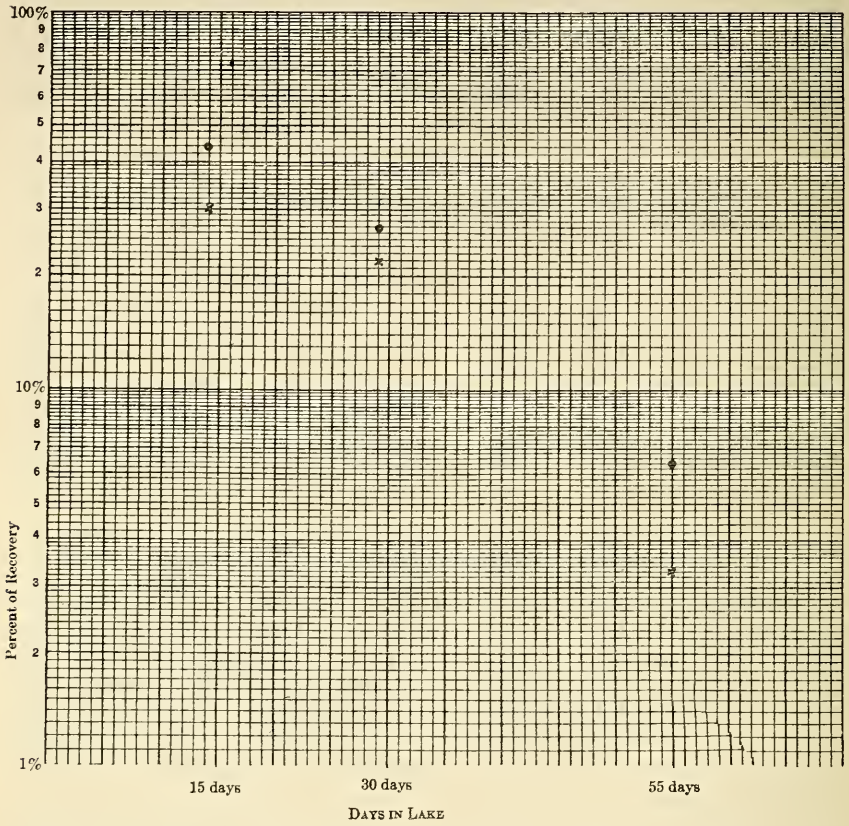

Figure 129. Survival of Fingerling Trout

Fish planted in lake in 1946
prior to date of poisoning

o Brook trout

× Rainbow trout

of the first-planted rainbow—3.3 percent—is below the *yield to the angler* for many of the earlier plants (See Table 5).

While the number of samples is too small for valid conclusions, the evidence discussed above indicates strongly that the recovery of the fingerlings which had been in the lake 55 days is well below the true survival, not only in the absolute, but also in relation to the survival of the later plantings.

Percentages of Castle Lake Fish "Accounted for" by Anglers and by Poisoning

If to the anglers' catches (1941-46 inclusive) are added the numbers of fish recovered at poisoning time, and if this sum is then divided by the number of fish planted in the years 1940-45 inclusive, the following percentages will result:

Brown trout	9.6%
Rainbow trout	5.6%
Brook trout	2.4%
Average	5.6%

These percentages indicate that even in the brown trout the number of fish which are killed by predators, by diseases, and by old age is relatively high. The need is also indicated for a break-down of the "unaccountable" loss to determine possible means of reducing this loss.

Loss From Predation

The analysis of the numbers of fingerlings recovered from the groups marked and planted at intervals of two months, one month, and two weeks before poisoning shows clearly that a very heavy loss occurs during the fingerling stage. The catch records from Castle Lake show that fingerling plants have a much lower survival than the yearling plants. The information from both sources clearly indicate that during the fingerling stage the loss is very high. Predation from one source or another must be the cause of this loss. There are usually several types of predators operating in any water. The survival of the brook trout planted in Castle Lake after the predatory browns and mackinaw have been removed will show us more about the role of cannibalism in mortality.

Loss From Disease

Diseased trout in Castle Lake and in most natural waters are apparently rare. It does not appear that this is a major factor in the "unaccountable loss." By avoiding the introduction of hatchery diseases into natural waters, we may feel that little more can or need be done to reduce this source of loss.

Loss From Old Age

The summaries of fish caught and poisoned show that neither the rainbow nor the brook attain "old age" in Castle Lake. Few live to be over three years old. In the browns, the story is different. A considerable number probably do die from old age. This can be considered an undesirable characteristic of this species, for these fish compete for food and eat the other trout and yet add nothing to the catch. Encouragement of fishing methods which would "select" the larger (older) individuals might be considered. However, the brown trout is not widely spread in California, and few are being planted at the present time, so this problem is not of great practical importance.

Loss at Spawning Time

We have no evidence that an abnormal loss occurs at spawning time in Castle Lake but this might be the case. There may be some loss from disease as the resistance of the fish is lower at that time. There is also the

TABLE 13

CASTLE LAKE

Length Averages of Poisoned Trout Recovered on October 9, 1946 *

Year class	1938 F	1939 F	1940 F	1941 F	1942 F	1942 Y	1943 F	1943 Y	1944 F	1945 F	1946 Y
Brown trout											
Length in cms.	47.8	28.3	28.1	28.2	26.7	26.9	25.7	27.0	22.4	15.5	-------
Number of specimens	3	28	87	67	317	43	159	24	710	589	-------
Brook trout											
Length in cms.	-------	-------	-------	-------	-------	-------	28.5	24.5	20.2	15.6	17.7
Number of specimens	-------	-------	-------	-------	-------	-------	4	1	19	26	364
Rainbow trout											
Length in cms.	-------	-------	-------	-------	-------	-------	-------	-------	26.4	22.5	-------
Number of specimens	-------	-------	-------	-------	-------	-------	-------	-------	11	31	-------
Mackinaw trout											
Average length in cms.	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	26.6
Number of specimens	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	78

* Fingerlings planted in 1946 not included.
F : Planted as fingerlings.
Y : Planted as yearlings.

possibility that some females die because they are unable to spawn their eggs. The lack of a suitable inlet stream may be particularly serious for rainbow and browns which prefer to spawn in running water. The brooks will use the springs rising in the bottom of the lake and so will not suffer as much as the other two species.

Winter-kill

Losses caused by severe winter conditions, particularly crushing by ice and snow, may well be important in Castle Lake though we have made no actual observations on such losses.

TABLE 14

Condition Factors of Castle Lake Fish

	1941	1942	1943	1944	1945	1946
Rainbow	1.02 (15)	1.00 (44)	1.05 (35)	1.01 (22)	1.02 (157)	1.17 (127)
Brown	1.02 (49)	1.00 (46)	.91 (25)	.86 (51)	.90 (318)	.98 (380)
Brook	1.03 (12)	.99 (36)	.88 (24)	.77 (7)	1.01 (14)	1.09 (275)

Figures in parenthesis are the numbers of fish used in compuling condition factors.

Condition factor formula: $K = \frac{W}{L^3} \times 100$

W = weight in grams; L = length in centimeters.

Summary

1. The present report summarizes the data secured from the 1946 anglers' catch and the data secured when the lake was poisoned on October 9, 1946.

2. In 1946, 667 anglers expended 2,674 hours at Castle Lake, and caught 1,275 trout. The average catch per hour (0.48 trout) and per angler-day (1.9 trout) indicates poor fishing, due perhaps in part to unfavorable weather. It would have been much worse if yearling brook trout had not been planted early in the season. Fifty percent of the catch in 1946 was made by 20 fishermen. This is a slightly better dispersal than in previous years. However, a season's catch of 16 fish was all that was necessary to be among the 20 best for 1946. The number of zero catches (57 percent of all angler-days) was higher in 1946 than heretofore.

3. The plant of 2,000 yearling brook trout made early in 1946 to improve the fishing distorted the distribution of species in the catch. When this plant is disregarded, the distribution in the 1946 catch is similar to that of previous years. The browns constituted over half the catch, less than one-fourth the catch were rainbows, and a still smaller fraction were brooks. This situation exists despite nearly equal plants of the three species.

4. Castle Lake was poisoned with 2,200 pounds of Cube powder to make possible the second phase of the investigation in which brook trout alone will be planted. A new and highly effective method of introducing the poison into the water is described.

5. The actual number of trout recovered after poisoning was 2,566, but many more sank in deep water, and could not be obtained. The number recovered may have been roughly one-half the fish present at that time. Distribution by species of the recovered fish was as follows:

Brown trout	2,027
Brook trout (planted in 1946 as yearlings)	364
Brook trout (planted prior to 1946)	50
Rainbow trout	44
Mackinaw trout	81
Black dace	several thousand
Golden shiners	several hundred

These figures do not necessarily represent the true proportion of the several species; it seems probable that a much higher proportion of rainbow was not recovered than was the case in the other species.

6. The contrast between number of trout caught by anglers in 1946 (1,275) and number recovered on poisoning (2,566), shows that many trout may be present in a lake even when angling is considered poor.

7. Fingerling rainbow and brook trout were planted in the lake at intervals up to two months prior to the poisoning time. Recoveries of these indicate a heavy mortality of small fish soon after planting.

8. Mortality from natural causes in Castle Lake among all species and ages was found to be very high (90-97 percent), while conversely, the percentage of all planted fish which were caught by anglers or poisoned on October 9th was low (3-10 percent). It is assumed that the major cause of this natural mortality is cannibalism.

References

Wales, J. H.

1946 Castle Lake Trout Investigation. First phase: Interrelationships of four species. California Fish and Game, Vol. 32, No. 3, pp. 109-143.

SECOND PROGRESS REPORT ON THE COOPERATIVE STUDY OF THE INTERSTATE DEER HERD AND ITS RANGE[1]

By Interstate Deer Herd Committee

Introduction

As a result of a meeting of members of the California Fish and Game Commission and the Oregon Game Commission with representatives of the United States Forest Service from Regions V and VI on the Modoc National Forest in May, 1945, a cooperative study of the interstate deer herd and its range was inaugurated in the fall of 1945. This problem had been under study for several years previously by personnel of the Modoc National Forest and others and was reported upon in 1944 and 1945 (Fisher, et al., 1944-1945). A progress report on the preliminary phases of the study was presented earlier (Interstate Deer Herd Committee, 1946).

The following report is a compilation of the several individual reports which the various field workers presented at the spring meeting of the field and advisory personnel.

The following personnel of the cooperating agencies were primarily responsible for the field and laboratory work: George A. Fischer and John C. Davis, Modoc National Forest; Randal McCain, Fremont National Forest; Avon Denham, Region 5, U. S. Forest Service; William Lightfoot, Robert Mace, and Winfred V. Masson, Oregon State Game Commission; James D. Stokes, Nathan L. Rogan, William P. Dasmann, John E. Chattin, Daniel Tillotson, Carol Ferrel, Carlton M. Herman, Merton Rosen, Melvin Brunkhorst, Donald D. McLean, and Albert Reese, California Division of Fish and Game.

An advisory board was composed of various representatives of the cooperating agencies. Semiannual meetings of field and advisory personnel were also attended by representatives of sportsmen's groups and livestock organizations, the U. S. Fish and Wildlife Service, and the University of California.

Range

The range of the interstate deer herd contains approximately 780,000 acres. There are about 406,000 acres in the summer range, mostly on the Fremont National Forest in Oregon, and 375,000 acres in the winter range, which is entirely within the boundaries of the Modoc National Forest in California (Fig. 130). This deer herd summers in Oregon and winters in California. It is composed entirely of Rocky Mountain Mule Deer *(Odocoileus hemionus hemionus)*. The deer share the forage crop with domestic livestock.

[1]Submitted for publication, July, 1947.

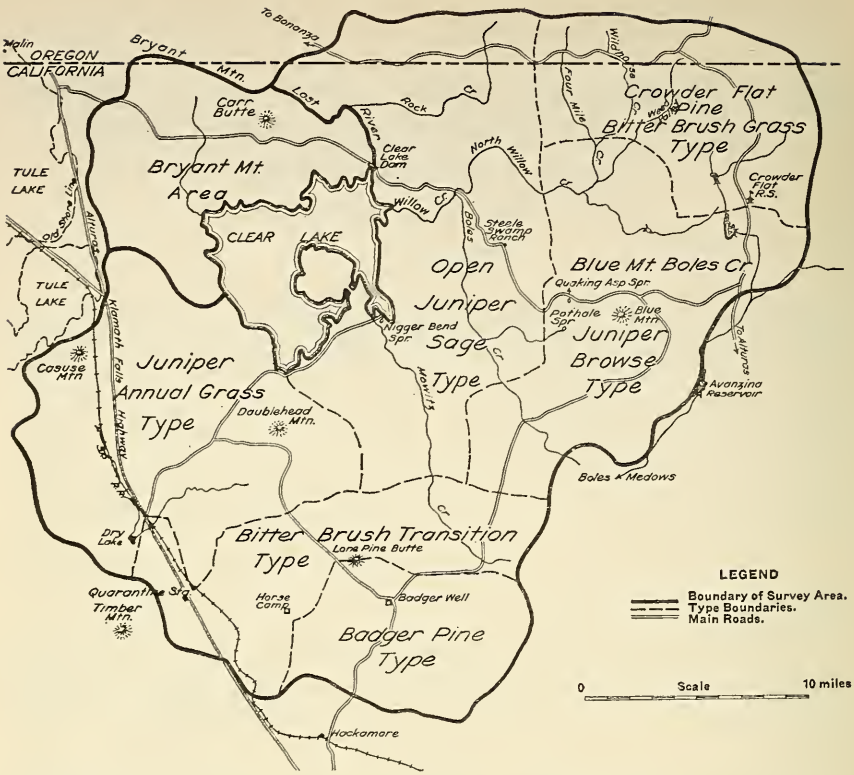

FIGURE 130. Winter Range of the Interstate Deer Herd Showing Vegetation Types and Principal Features

Livestock Numbers

There is no apparent problem on the summer range at the present time. The Fremont National Forest permits 21,335 cow months of livestock grazing on the area it administers at the average rate of 19.0 acres per cow month.

During the last five years the Modoc National Forest has made reductions in permitted livestock use on the deer winter range of 30 percent for sheep and 22 percent for cattle. At the present time, 23,170 cow months of livestock grazing are permitted on the area, at a rate of 16.2 acres per cow month. Table I shows permitted livestock use on grazing allotments on the deer winter range.

Climate and Weather

During the three years 1944-46, the winters were mild and open. During the winter of 1946-47, neither severe temperatures nor excessive snowfalls occurred at any time. Cold snaps and storms were few and of short duration. Except for very short periods, the ground surface was bare of snow all winter, thereby providing ample ground forage for the deer. Muddy periods causing difficult travel for deer were short.

TABLE I

Grazing Allotments

Allotment	Acreage*	1946 An. Unit Mos.	Acres/Mo	Season
North Badger	13,000	900	14.4	6/1- 9/30
South Badger	12,000	1,000	12.0	6/1- 9/30
Hackamore	16,000	1,000	16.0	6/1- 9/30
Clear Lake Spring†	92,000	6,995	13.2	4/1-10/15
Boles Meadow	174,000	9,750	17.8	5/1-10/15
Dry Lake†	25,000	1,275	19.6	4/16-10/15
Potter Pasture†	17,000			6/1- 9/30
Mowitz	16,000	1,750	9.1	5/1- 9/30
Casuse Mountain	10,000	500	20.0	4/1- 5/31
Totals	375,000	23,170	16.2	

* This is gross acreage and includes private land, used with National Forest land.
† These allotments make up the area upon which deer concentrate during the mid-winter period.

Migrations

According to the men in charge of a deer trap on the state line, the southward migration began about September 20th (about a month earlier than usual). This migration reached its peak between October 15th and 20th, and was practically completed by October 20th. The first storm of any magnitude occurred between October 5th and 9th. This presumably caused the main movement. The next storm began about October 18th and this apparently resulted in completion of the migration.

During December, deer were well distributed over the entire area with about 40 percent of the herd concentrated in the bitterbrush area. By mid-January approximately 50 percent of the herd was found in the Bitterbrush-transition type and slightly less than 40 percent in the Juniper-Annual grass type.

Between February 15th and 20th deer moved into the Badger Pine type, which constituted a retracing of the earlier southward route, rather than following the circular route of previous years (Fischer, et al., 1944). By the end of February most of the deer had returned to the Juniper-Annual grass type from the Badger Pine type.

The first indication of the northward return migration was noted about March 15th, and by March 19th the vanguard reached Blue Mountain.

Censuses

1. Car Strip Counts

In conducting the 1946-47 censuses the strips devised in 1943-44, with strip widths as modified in 1945-46, were used (Fig. 131). Counts were made once each month at about mid-month to correspond as closely as possible to counting dates of other years. Methods of previous years were used in censusing and classifying the herd. Counts were made from motor vehicles along sections of road designated as sampling strips. For each strip an estimate was made of the average width of the area visible in which deer would be counted. The length of the strip was measured on the speedometer. From this the area of the strip was calculated. The strip counts were converted into deer per square mile, which was applied to the area of the unit.

FIGURE 131. Winter range of the interstate deer herd showing the unit boundaries used in this study

All strips were covered each month except in cases where strips were known to contain no deer or so few deer that census numbers would not be materially affected. In one instance back country roads were impassable and as a result the Blue Mountain area was not censused in February. Motor vehicles were used for transportation throughout the winter.

Herd Size and Classification

Table II shows computed populations in the principal census types (established by Fischer et al.) by periods over the winter of 1946-47. The computed totals for individual months during the December to March period were consistently at or above the 12,000 mark. The totals for the four months were averaged at 12,400. This figure was considered to be the approximate size of the herd for the 1946-47 period.

Another group of deer, the Glass Mountain herd, winters on an area immediately west of the interstate deer herd range. The number and composition of this herd have been compared with that of the interstate deer herd each year since 1944. Census figures of the Glass Mountain herd for the corresponding period are presented in Table III. Due to the open winter and low snowfall on the Glass Mountain range, some of these deer were not forced to the lower and more accessible part of the winter range. Deer were found in the timber high on the mountain in mid-winter where they had never been seen during the same period in previous years.

Tables IV, V, VI, VII, and VIII are included in the present progress report to show trends in numbers and changes in composition.

Table VII provides figures for comparison with earlier censuses, and with counts on other herds. These figures are based on nearly 30,000 sight records.

TABLE II

Deer Populations in the Principal Forage Types, 1946-47

	November	December	January	February	March
Blue Mountain-Boles	2,215	2,268	1,801	*2,800	4,937
Badger Pine	2,120	2,398	22	2,605	932
Bitterbrush	2,186	5,076	6,371	2,291	1,275
Juniper annual grass	380	2,069	5,005	3,799	2,556
Open Juniper Sage	0	266	0	*150	2,415
Totals	6,901	12,077	13,202	11,645	12,115

* Estimated numbers.

TABLE III

Total Numbers of Deer in Glass Mountain Herd, 1946-47

	November	December	January	February	March
Glass Mountain	414	2,223	4,190	1,561	735

TABLE IV

Interstate Deer Herd—Herd Composition for Past Four Years of Study

	1943-44		1944-45		1945-46		1946-47	
	Number	Percent of herd	Number	Percent of herd	Number	Percent of herd	Number	Percent of herd
Bucks	1,548	8.6	1,440	8.0	870	6.4	1,116	9.0
Does	13,376	63.2	9,900	55.0	8,215	60.4	7,068	57.0
Fawns	5,076	28.2	6,660	37.0	4,515	33.2	4,216	34.0
Totals	18,000	100.0	18,000	100.0	13,600	100.0	12,400	100.0

TABLE V

Interstate Deer Herd—Buck Trend by Antler Point Classes

Points	1943-44		1944-45		1945-46		1946-47	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	77	5	130	9	70	8	112	10
2	465	30	403	28	226	26	279	25
3	465	30	360	25	226	26	245	22
4	433	28	489	34	331	38	335	30
4-plus	108	7	58	4	17	2	145	13
Totals	1,548	100.00	1,440	100.00	870	100.00	1,116	100.00

TABLE VI

Buck-Doe and Doe-Fawn Ratios by Census Years

Interstate Herd

Year	Buck-doe ratio	Doe-farm ratio	Number of deer classified
1937-38	1:5.6	1:0.81	1,262
1938-39	1:3.5	1:1.25	2,882
1939-40	1:4.9	1:1.03	1,338
1943-44	1:7.4	1:0.45	5,986
1944-45	1:6.6	1:0.67	3,007
1945-46	1:9.5	1:0.54	1,696
1946-47	1:6.2	1:0.61	1,603

Glass Mountain Herd

Year	Buck-doe ratio	Doe-fawn ratio	Number of deer classified
1944-45	1:3.8	1:0.71	432
1945-46	1:3.9	1:0.65	587
1946-47	1:4.0	1:0.60	437

TABLE VII

Ratio Composition of Various Mule Deer Herds

Area	Years	Buck-doe	Doe-fawn
Modoc average	1937-45	1:5.4	1:0.70
Modoc	1946-47	1:6.2	1:0.61
Glass Mountain	1946-47	1:4.0	1:0.60
Fremont average	1936-45	1:3.0	1:0.60
Utah	1939-43	1:2.8	1:0.70

TABLE VIII

Percentage Composition of Various Mule Deer Herds

Area	Year	Percent bucks	Percent does	Percent fawns	Number of deer classified
Modoc average	1937-45	10	53	37	14,475
Modoc	1946-47	9	57	34	1,603
Glass Mountain	1946-47	14	54	32	437
Fremont average	1936-45	17	51	32	12,137
Utah	1939-43	17	45	38	2,529

Composition of these herds, Table VIII, was computed by converting the ratios presented in Tables VI and VII into percentages.

Robinette and Olsen (1944) made a sex-ratio check of a mule deer herd in Utah and in a classification of 2,529 deer reported a ratio of 17.2 percent bucks, 38 percent fawns, and 44.8 percent does. The interstate deer herd at the last census showed only half the percentage of bucks (9 percent of the herd) of either the Utah or Fremont herds. The figures presented in Table VIII indicate the differential in herd composition between the interstate herd and herds in other parts of the country.

Drive Count

On February 16, 1947, a drive count was made over the same area of four sections that was driven in 1946. Three counters were located along a high ridge on the western edge of the area. Seven drivers were dropped off along the road at four-tenth mile intervals. These men worked northward through the area. The weather was warm with few clouds and a light west wind. The drive began at 2 p.m. and continued for approximately one hour. Many deer were reluctant to leave cover, milled about, and cut back through the drivers, making counting conditions difficult. After eliminating all known sources of error and duplication, a total count of 594 deer was obtained for the area, or 148 deer per section. The accuracy of the drive count is questionable and no significant correlation can be made between the drive count and other census methods applied to the same area.

State Line Track Count

The track count of the northward spring migration of the interstate deer herd across the California-Oregon state line (Table IX) was made between April 10 and April 29, 1947. It was made along the state line road between Fort Springs (milepost 19) and Yokum Valley (milepost 10), a distance of nine miles. Daily counts were made on horseback and tracks were tabulated between mileposts. Southbound tracks were subtracted from the northbound tracks to obtain the total number of northbound deer. The strip was dragged each day with a brush drag to obliterate old tracks. The counting strip which was made by the drag averaged approximately three feet in width and after the first few days

TABLE IX

State Line Track Count—Interstate Deer Herd, 1947

Area	Count	Estimate	Total
Willow Reservoir to Adobe Flat		500	500
Adobe Flat to Fort Springs		1,000	1,000
Fort Springs to M. P. 18*	528		528
M. P. 18 to M. P. 17	1,773		1,773
M. P. 17 to M. P. 16	1,864		1,864
M. P. 16 to M. P. 15	881		881
M. P. 15 to. M. P. 14	984		984
M. P. 14 to M. P. 13	849		849
M. P. 13 to M. P. 12	1,954		1,954
M. P. 12 to Stateline Spr.	122		122
M. P. 11 (Stl.) to M. P. 10 (Yk.)	929		929
M. P. 10 to Young Valley	942	558	1,500
Young Valley to Goose Lake		1,000	1,000
Totals	10,826	3,058	13,884

* (M. P.=Mile post)

provided an excellent track bed on all but the very hard or grassy surfaces. Even in the muddy areas, the old tracks were filled with bits of debris so that the fresh tracks could be distinguished without difficulty. On the dry surface, a fine dust mulch soon formed so that the new tracks showed up very well and brushed out easily. Only about one-half mile of the total road surface in the nine-mile strip was difficult to count and, fortunately, most of these small areas were in places where few deer

crossed. The migration started across the state line on or about the first of April and the peak occurred on April 14th. Counting was discontinued on April 29th when the daily count had dropped to 61 deer per day. It is probable that several hundred deer still remained to cross the counting strip. The tracks counted for the nine-mile strip from Fort Springs to Yokum Valley was 9,884 (Figs. 132 and 133).

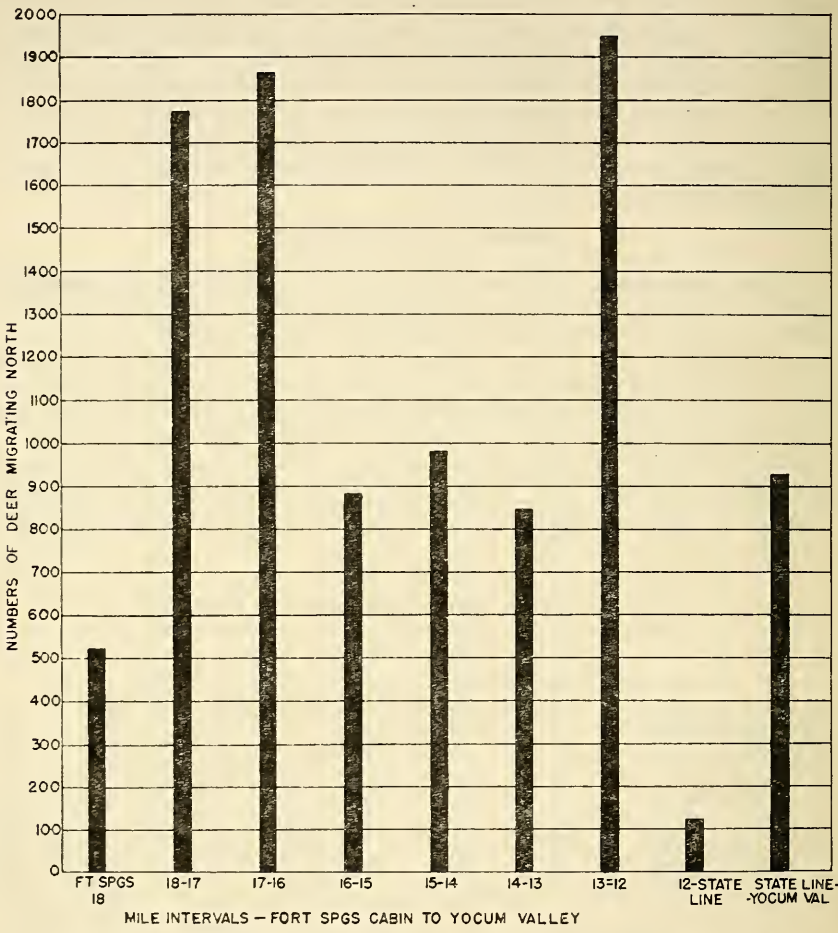

FIGURE 132. Numbers of deer migrating north between milepost intervals—Ft. Springs Cabin to Yokum Valley, April 1-29, 1947

On April 22d a count was made of all tracks from the east end of the counting strip to Young Valley. A total of 942 northbound tracks (after subtracting the southbound tracks) was recorded. Counting conditions were difficult as only fresh tracks and those made earlier in the mud could be easily distinguished. It was estimated from this count that 1,200 deer had already crossed this area and that a total of 1,500 deer would cross by the end of the migration. It was further estimated that 500 deer crossed the line between Adobe Flat and Fort Springs. An additional

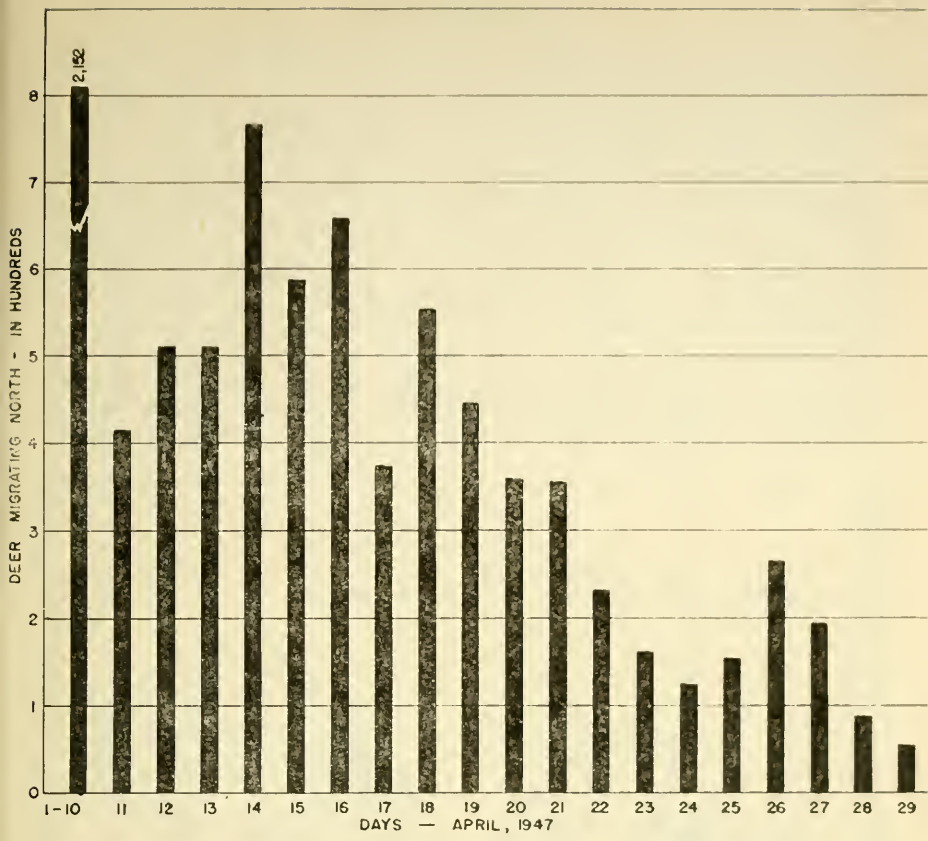

FIGURE 133. Numbers of deer migrating north (Total northbound tracks minus total southbound tracks) between Ft. Springs Cabin and State Line Cabin, April 11-29, 1947.

1,000 deer were estimated to have crossed the state line from Young Valley to Goose Lake. It is probable that the majority of these deer wintered along the Goose Lake rim and do not constitute a part of the main interstate herd. Based upon the track count, the total number of deer crossing from California into Oregon on the spring migration of 1947 was estimated at 13,884 head. This estimate is based on a track count of 10,826 head and an additional estimate of 3,058 head. Excluding the 1,000 head of deer crossing the state line east of Young Valley leaves 12,884 deer in the interstate deer herd wintering on the Modoc problem area.

Pellet Group Counts

During March and April, 1947, a total of 155 pellet sample plots were established and the pellet groups counted. This was accomplished in 42 man-days of field time. The plots were spaced one-half mile to 1½ miles apart. Eighty-five of the plots were established by the use of a surveyor's tape. The measured plots were 22 chains in length [1] and were paralleled with one, two, or three companion strips of equal length. The number of companion strips at a plot depended upon the number of men available. With two exceptions, the plots were all six feet in width. The remainder of the plots were laid out by pacing and all plots were composed of five parallel strips 6 feet x 11 chains. These dimensions were used because they contain an area of one-tenth acre or its multiple.

The number of pellet groups counted for each plot has been converted to groups per acre and then to deer days by the use of the conversion factor of 12.7 groups to one deer day. Table X contains the summary of the 1947 computations. It includes use by resident deer and use

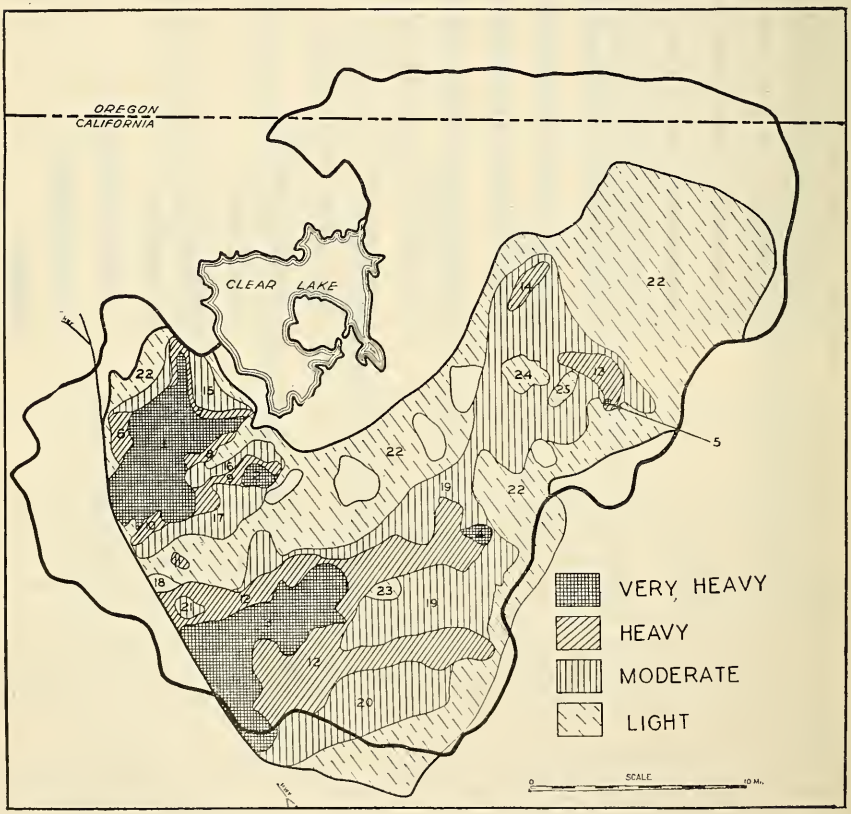

FIGURE 134. Intensity of deer use as shown by pellet group counts on main part of range. Heavy boundary line is the boundary of the winter deer range, shaded areas show range covered in pellet group count. Very heavy, over 20 deer days per acre; heavy, 10-19 deer days per acre; moderate, 5-9 deer days per acre; light, 1-4 deer days per acre.

[1] One chain equals 66 feet.

TABLE X

Summary of 1946-47 Pellet Group Counts

Unit No.	Type	Area—square miles		Number of plots	Deer months use
		Area on which use was estimated	Sampled area		
3	Crowder Flat—Pine	13.3		0	(1,000)
4		*32.8		0	(2,000)
5		*25.6		0	(800)
6		*23.8		0	(2,000)
Total		95.5		0	(5,500)
8	Blue Mt.—Boles Creek—Juniper Browse	11.1		0	(1,300)
9		12.4		0	(1,000)
9A		32.4		0	(1,000)
11			9.4	6	2,100
12			9.8	4	600
13			22.6	6	2,300
14			15.4	5	2,400
Total		55.9	56.9	21	(10,400)
15	Badger—Pine		8.4	4	1,400
15A			12.8	5	1,900
15B			11.5	4	1,900
17			5.6	4	2,500
19		5.2		0	(500)
20		13.2		0	(2,000)
Total		18.4	38.3	17	(10,200)
14A	Bitterbrush—Transition		11.4	4	3,300
16			12.8	6	2,500
18			5.1	7	3,500
21			6.8	4	4,900
22			8.3	8	3,600
23			7.1x½	7	5,200
26			11.6	5	4,900
29A			5.6	2	1,800
31			6.3x½	3	1,200
Totals			75.0	46	30,900
25A	Juniper—Grass		7.3	3	1,200
26A			10.1	6	800
27			4.6	7	1,600
28			10.2	7	2,200
29			7.1	3	1,300
29B			7.7	6	1,700
30			5.7	10	2,800
32			5.4	9	2,900
33			5.1	10	3,200
34			18.6	14	6,200
39		15.9x½		0	(1,000)
40		10.5x		0	(500)
41		15.6x		0	(400)
42		6.1x		0	(500)
Totals		48.1	81.8	75	(26,300)
7	Open Juniper—Sage	45.8x½		0	(500)
10			10.2	1	1,400
10A		46.4		0	(500)
24		21.7		0	(500)
25		15.9		0	(800)
38		49.1x½		0	(1,000)
Totals		178.9	10.2	1	(4,700)
Grand totals		396.8	262.2	160	(88,000)
	Other areas used by interstate deer herd	50.0		0	(500)
	Total herd range	446.8	(709)		(88,500)
	Deer number obtained by dividing deer—mo. by 5.73 months				15,500

(Figures in parenthesis are estimates only.)
* Usually considered as summer range and not included in Table X1.
x Other areas not included in Table X1.

on some areas not generally considered as winter range. Areas which show similar degrees of use are grouped into four classifications shown in Figure 134. The study indicates that small areas of heavy concentration furnish as much deer food as very large areas of low use (See Table XI).

Table XI shows data on the main wintering area converted to deer months of use. The 370,500 acres of winter range, herein tabulated, received a total of 68,400 deer months of use according to estimates based upon pellet group counts. The deer herd entered this area about October 25, 1946, and left about April 15, 1947. The average deer spent 172

TABLE XI

Deer Use on Winter Range

Class of use deer-days per acre	Average	Acres in each class	Number of deer-days for each area	Number of deer-months for each area
0 to 1	½	139,500	70,000	2,300
1 to 5	2½	128,000	320,000	10,700
5 to 10	7½	43,500	326,000	10,800
10 to 15	12½	11,500	146,000	4,900
15 to 20	17½	23,700	412,000	13,700
20 to 30	25	12,800	320,000	10,700
30 to 50	40	11,500	460,000	15,300
Totals*		370,500		68,400

* Note: The East Devil's Garden and area west of state highway not included. Sampling areas 35, 36 and 37 excluded, also one-half areas 7 and 38 (Fig. 131).

days or 5.73 months on the area. The total deer months divided by the total time (68,400 ÷ 5.73) indicates a population of 12,000 head. If the average deer spent more or less time on the area, the total population figure would change.

The pellet group plots were made to coincide with 20 established bitterbrush utilization plots (see page 290). The relationship of forage density, percent use by deer and deer days as determined by pellet group counts was studied. These data were not conclusive but did point out the possibilities of the method. It was observed that range with a density of 10 square feet per hundred furnished about 40 deer-days per acre when properly utilized. When the density was 20 square feet, an acre furnished 60 deer-days of use.

Airplane Counts

On February 18th, 19th, and 20th, a Fairchild 24 airplane was used to count the interstate deer herd. Two men, the pilot and one counter, were used. The area was divided into seven blocks which were covered by flying in relatively evenly spaced laps from east to west and return, working from south to north in order to have the sun behind the observer. The laps averaged 2.7 to the mile in spacing and were flown at various heights depending on the terrain and cover, flying low over junipers at 75 to 125 feet and 100 to 300 over open country. True courses were maintained by use of the gyro-compass. Buttes were flown independently in a rising spiral, since it was found in the past that this method was the most efficient in this type of area. The figures obtained are summarized in Table XII.

No attempt was made to count deer in the timbered area on the south edge of the study area. Since the ground was soft because of recent rains, tracks could be seen fairly easily and some bands were actually tracked down. Deer were seen easily on areas of bare ground and open brush and could be seen almost as easily on areas of Juniper cover type. In this type deer would either be standing in the open watching the airplane as it approached or would bound out into the clear as the airplane passed over them. No difficulty of duplication was caused by deer drifting ahead into uncounted areas.

All bands that were not easily counted from the air were photographed with a "K-20" aerial camera and counted from the photograph.

Figure 135 shows the area surveyed, the areas where deer were seen and the deer counted in each block. Deer were working northward in long tongues along the firm ground and rocky ridges. It is of interest to note

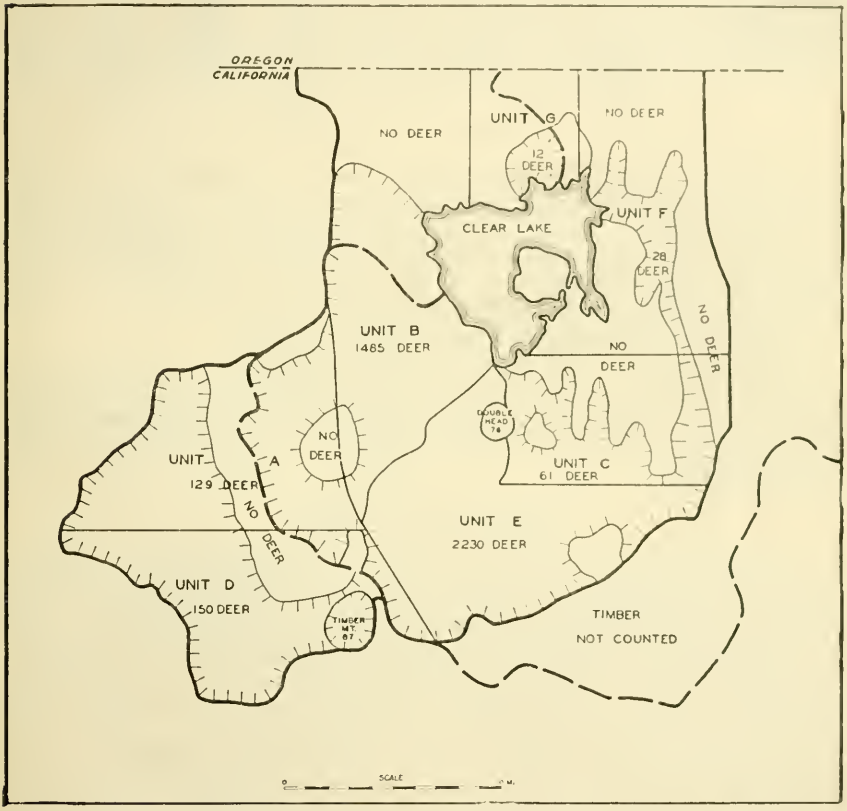

FIGURE 135. Airplane deer counts by units, February 18, 19, and 20, 1947

that a definite separation of the Glass Mountain herd and the Interstate herd was observed.

The observers estimated that they recorded 65 percent of the deer on the area, which would make a total of 6,552 deer present on the area.

It is felt that the count was fairly accurate for this first attempt, but improvements in method should be made in future counts.

Comparison of Census Methods

Track counts on the northward migration gave the number of deer on the interstate migration as 12,884.

The *car strip census* gave the population as 12,400, which should be conservative due to the apparent assumption that all deer on the strip

TABLE XII

Summary of Airplane Count, 1947

Area	Sq. mile area	Laps	Miles flown	Time	Date	Number of deer seen	Est. total number of deer
Sand Flats	67	21	147	9:00-10:30	18th	150	231
Lava Beds	83	23	230	10:30-12:45	18th	129	200
Clear Lake Hills	100	64	384	9:00-12:45	19th	1,485	2,285
North of Clear Lake Hills	28	13	65	12:45- 1:35	19th	12	18
Deer Hill to Clear Lake Road	103	38	380	8:30-12:10	20th	2,230	3,430
East of Clear Lake	80	35	210	1:10- 2:50	20th	28	43
East of Doublehead	57	14	140	2:50- 4:20	20th	61	94
Timber Mountain	4.5	spiral	----------	----------	18th	87	134
Doublehead	2	spiral	----------	----------	19th	76	117
Totals	524.5	208	1,556	15 hrs. 15 min.	----------	4,258	6,552

were seen and recorded in spite of the fact that counts were made at all times of the day. The data are difficult of analysis, but inspection of the records indicates that mid-day counts averaged but 55 percent of those in the morning or evening. If the latter were 100 percent accurate, the average number of deer seen would be above 85 percent of the total number on the strip. This would indicate a population of 14,500.

Pellet group counts gave a population of 12,000.

On the *airplane count,* 4,258 deer were sighted. These were believed to be 65 percent of the number in the area flown, or 6,550 animals. To these should be added the number obtained by car strip census in the Blue Mountain and Badger Pine areas not flown, or 5,400 animals, giving a total of 11,950.

State Line Deer Trap

The state line deer trap was originally constructed in the summer of 1945. Its purpose was to trap and mark a sufficient number of the interstate herd so that their winter movements and distribution could be observed on the winter range. The trap is a drift wing type built so as to deflect rapidly migrating deer into a central holding corral from which they can be moved through a squeeze chute to be marked and tagged.

The following improvements were made on the trap during the past season:

Fish net which was used in the wings was replaced with 60-inch woven wire netting and the wings were lengthened and straightened. The inside of the holding corral was lined with small pine saplings placed very close together to act as a shock absorber for deer butting the fence. A circular pole corral with a 14-foot swinging gate was constructed at the southeast corner of the holding corral to handle the deer after they were trapped. A wire wing extending toward the middle of the holding corral to deflect deer into the handling corral was erected. A tree house

was built to the west of the trap to facilitate observation and closing of the main gate.

Successful operation of the trap is largely dependent on a fast migration forced on by stormy weather. During the past trapping season, no severe storms occurred. The deer drifted through slowly over a prolonged period of time. The migration was first noted about the middle of September and continued until the last of October. The trap was operated during most of the month of October, but with little success owing to the slow migration. During the night of October 21st, four does were caught and were successfully marked, tagged, and released. Two does and one spike buck where caught on the night of October 26th and were successfully marked, tagged, and released. No other deer were caught during the trapping period.

A drive was attempted on October 23d with 19 drivers participating. Seven deer were forced to within 20 yards of the main gate of the holding corral but then broke back through the line of drivers who were about 15 yards apart at that point. Two deer went through the west wing, tearing down 200 yards of the wire netting. It was decided that driving as a method of getting deer into the trap was not satisfactory.

FIGURE 136. Distribution of plots for bitterbrush utilization measurements. Black rectangles, Study A; Open rectangles, Study B

Lack of success in operating the trap this past season was attributed largely to the slow leisurely type of migration. Deer caught in the trap were handled successfully. None of the marked deer were noted in the subsequent census work.

Bitterbrush Utilization Study

Two independent studies were made of the use of the 1946 bitterbrush forage crop on the interstate deer herd winter range (Fig. 136). Thirty-six sample plots, consisting of transects of 20 shrubs each, were established at right angles to principal roads throughout the range. Degree of cropping was determined by visual estimate (Table XIV) of the percent of current growth that had been cropped from the shrubs. The method was the same as that used in bitterbrush studies by Hormay (1943) of the California Forest and Range Experiment Station.

Study "A" (Table XIII), composed of 19 plots, sampled the Badger Pine, Bitterbrush-transition and Juniper-annual grass areas. The plots were established in early October, 1946, after all livestock, except a few scattered cattle, had been removed but before deer arrived on the

TABLE XIII

Analysis, Study A—Bitterbrush Utilization Study—Interstate Deer Herd

Visual Estimate

Plot number	Percent total use	Percent livestock use	Percent deer use	Area classification	Range survey density
1	52.2	39.7	12.5	Badger Pine	.13
2	54.5	20.7	33.8	Badger Pine	.13
3	85.7	70.3	15.4	Badger Pine	.12
4	81.7	72.7	9.0	Badger Pine	.12
5	Plot	burned off		Bb.—Transition	.20
6	86.2	59.0	27.2	Bb.—Transition	.16
7	65.5	0.3	65.2	Bb.—Transition	.15
8	83.5	51.5	32.0	Juniper—An. Gr.	.10
9	87.0	57.7	29.3	Juniper—An. Gr.	.08
10	47.2	1.3	45.9	Bb.—Transition	.14
11	62.2	2.7	59.5	Bb.—Transition	.18
12	86.1	52.0	34.1	Bb.—Transition	.15
13	95.9	88.5	7.4	Bb.—Transition	.17
14	32.7	4.5	28.2	Bb.—Transition	.20
15	88.6	60.5	28.1	Juniper—An. Gr.	.13
16	82.0	56.2	25.8	Juniper—An. Gr.	.13
17	90.5	55.0	35.5	Juniper—An. Gr.	.07
18	91.9	74.9	17.0	Juniper—An. Gr.	.10
19	44.2	0.0	44.2	Badger Pine	.19
20	70.5	0.0	70.5	Juniper—An. Gr.	.07
Average	73.0	40.4	32.6		

range. Since observations indicated that few, if any, deer were on the area sampled during the period in which bitterbrush makes its annual growth, or after, until late October, it was assumed that livestock consumed all growth taken when the first observations were made. Utilization was estimated again in April, 1947, before livestock returned to the range. It was assumed that any additional cropping of bitterbrush over that recorded the previous fall was made by the deer that had wintered on the area in the interval.

It had been determined by Hormay (op. cit.) that bitterbrush can maintain itself and reproduce if 40 percent of its annual growth is left

in place on the shrub each year. Forty percent of its annual growth is the metabolic factor of a bitterbrush shrub; the other 60 percent making up the allowable crop factor that may be consumed without damage to the shrub. Where more than 60 percent is taken, the shrub is weakened. If overcropped year after year, the shrub will produce less and less forage, will become a weak seeder and will die prematurely.

An analysis of the sample secured in the fall of 1946 indicates that livestock are damaging this important forage plant. The sample indicates that 40 out of every 100 bitterbrush shrubs were overcropped when livestock had left the area in the fall. Overcropped shrubs were found on 14 out of the 19 sample plots and ranged from 3 to 20 shrubs per plot.

When the plots were reexamined in the spring, it was found that additional use by deer resulted in raising the number of overcropped shrubs per 100 from 40 to 74. Such shrubs were found on every one of the 19 established plots, ranging from 2 to 20 shrubs per plot.

This data may be compared as follows:

Livestock overcropped	40 percent of the shrubs
Deer and livestock overcropped	74 percent of the shrubs

Arithmetical averages of the over-all use of the annual growth on all shrubs indicate that:

Livestock used	40.4 percent
Deer used	32.6 percent
Total use was	73.0 percent

It is quite possible that deer use might have been greater had livestock left more for them. On part of the Juniper-annual grass area, in the deer winter concentration area, livestock took 89 percent of the annual bitterbrush growth. Of the 20 shrubs in the sample not one was cropped less than 70 percent.

In addition to the visual estimates analyzed above, cropping of bitterbrush was sampled by a ruler measurement method. One lateral branch group on each of the last four shrubs on each transect was tagged just below the first prominent forking, and all annual leader growth occurring above the tag was measured to the nearest one-quarter inch with a ruler. When plots were rechecked in the spring the remaining annual growth was measured. The difference between the first and second measurement was considered the amount cropped by deer. It was found that deer had consumed 69 percent of the forage that remained the previous fall.

The visual estimates for each of these tagged shrubs (76 in all) were then grouped and averaged for comparison purposes. It was found that where visual estimates gave a use by deer of 34 percent, the measured branch groups indicate that deer took 41 percent.

All data (as well as general observation) indicate that bitterbrush is severely overcropped under present stocking. Grouping data by areas, shows that the average number of overcropped shrubs was:

Badger pine area	11 out of 20 shrubs
Bitterbrush-transition	13 out of 20 shrubs
Juniper-annual grass	19 out of 20 shrubs

Study "B" (Table XIV), composed of 17 plots, sampled the Juniper-annual grass, Bitterbrush-transition, Blue Mountain-Boles Creek juniper-browse and the Crowder Flat bitterbrush-grass areas. The data secured yielded the following information which may be compared with the results of Study "A," above:

TABLE XIV

Analysis, Study B—Bitterbrush Utilization Study

Visual Estimate

Plot number	Use in May Percent	Use in October Percent	Percent deer use	Area classification
1	79	40	39	Juniper-annual grass
2	81	60	21	Juniper-annual grass
3	86	62	24	Bitter-brush-transition
4	55	4	51	Bitter-brush-transition
5	85	59	26	Bitter-brush-transition
6	Destroyed	by logging		
7	Destroyed	by logging		
8	56	28	28	Blue Mountain-Boles Creek juniper-browse
9	77	57	20	Blue Mountain-Boles Creek juniper-browse
10	70	62	8	Blue Mountain-Boles Creek juniper-browse
11	56	50	6	Blue Mountain-Boles Creek juniper-browse
12	80	64	16	Crowder flat bitterbrush-grass
13	61	50	11	Crowder flat bitterbrush-grass
14	73	71	2	Crowder flat bitterbrush-grass
15	84	77	7	Crowder flat bitterbrush-grass
16	78	69	9	Crowder flat bitterbrush-grass
17	76	67	9	Crowder flat bitterbrush-grass
18	83	66	17	Crowder flat bitterbrush-grass
19	15	----------	15	Control plot—deer use
20	74	25	49	Crowder flat bitterbrush-grass
Average	74	54*	20*	

* Note: It was estimated that resident deer use during the summer months approximately 10 percent of the bitterbrush crop in areas sampled by plots 12 to 20. This decreases the average cropping attributed to livestock by 5 percent and increases that for deer by a like amount.

Livestock used ---------- 49 percent of the total available growth
Deer used ---------- 25 percent of the total available growth

Total used ---------- 74 percent of the total available growth

When livestock left the range in October, 1946, 60 percent of the shrubs sampled had been cropped to a degree of 60 percent or greater and 42 percent had been overbrowsed. Additional cropping by deer during the winter months resulted in 89 percent of the shrubs being cropped 60 percent or greater and 82 percent of the sample overbrowsed. Eleven shrubs (3 percent of the sample) died during the October-May period.

The utilization averages for each area as determined from the combined data of the two studies are presented in Table XV.

While the sampling of bitterbrush utilization was hardly intensive enough to be used as a management base, it is sufficient to show the need for reduced stocking on this deer-livestock range. If further damage to this important forage plant species is to be prevented and the browse range allowed to recover vigor and density, either livestock or both deer and livestock must be reduced.

In making any division of the bitterbrush forage crop between deer and livestock, it should be remembered that on the interstate deer herd winter range livestock crop bitterbrush at a time when it is in full leaf.

TABLE XV

Bitterbrush Use by Type, Study B (See Map, Fig. 136)

Type	Percent of annual growth		
	Total use	Livestock use	Deer use
Juniper-annual grass	84	51	33
Bitterbrush-transition	70	33	37
Badger Pine	64	41	23
Blue Mountain-Boles Creek	65	49	16
Crowder Flat Bitterbrush grass	76	61	15

Deer take it after the leaves are falling or already shed. It has been determined that the weight of leaves on a bitterbrush twig roughly equals the weight of the twig itself. Hence deer actually consume a much lesser volume of forage than the study indicates, while livestock actually consume more.

Grass Utilization Survey

Deer take considerable quantities of dry grass throughout the winter when it is not covered with snow. The quantity of this material removed by deer is not considered injurious to the plants. Green grass in the early stages of growth is taken whenever available.

A survey to determine the degree of cropping of green range grasses by deer on the winter concentration area was made in late March and early April, 1947. Lines of plots were run at mile and mile and a half intervals at right angles to principal roads. The utilization of green grass was estimated on square-foot plots which were placed one chain apart, usually 10 to a transect. Fifty transects containing 526 square-foot plots were measured by visual estimate to the nearest 10 percent, of the percent of green growth taken.

An analysis of the plot data (Table XVI) indicates that the average over-all use of grass by deer was less than 5 percent of the green

TABLE XVI

Grass Utilization by Deer

Range forage type	Number of grass plants	Percent of total grass plants cropped	Average amount taken, percent	Average amount taken-all grass plants, percent
1. Grassland	60	28	21	6
3. Perennial forbs	189	60	17	9
4. Sagebrush	669	21	22	5
5. Browse-shrub	93	45	19	9
6. Pine	200	25	13	3
9. Juniper	198	35	14	6
All types	1,407	32	17	5

growth available at the time of sampling. Thirty-two percent of the plants in the sample had been cropped by deer and from these the deer had taken an average of 17 percent of the green growth.

This study indicates that deer make widespread use of grass during the time they are on the winter range and this use appears to be heaviest in the perennial-forbs and the browse-shrub types. It would appear that the use of grass by deer on the winter concentration area is significant but hardly heavy enough to cause damage to this class of vegetation.

Food Habits

During the period covered by this report 53 deer were collected and the contents of the stomachs analyzed by the Food Habits Laboratory, California Division of Fish and Game (Fig. 137). Collection of 50

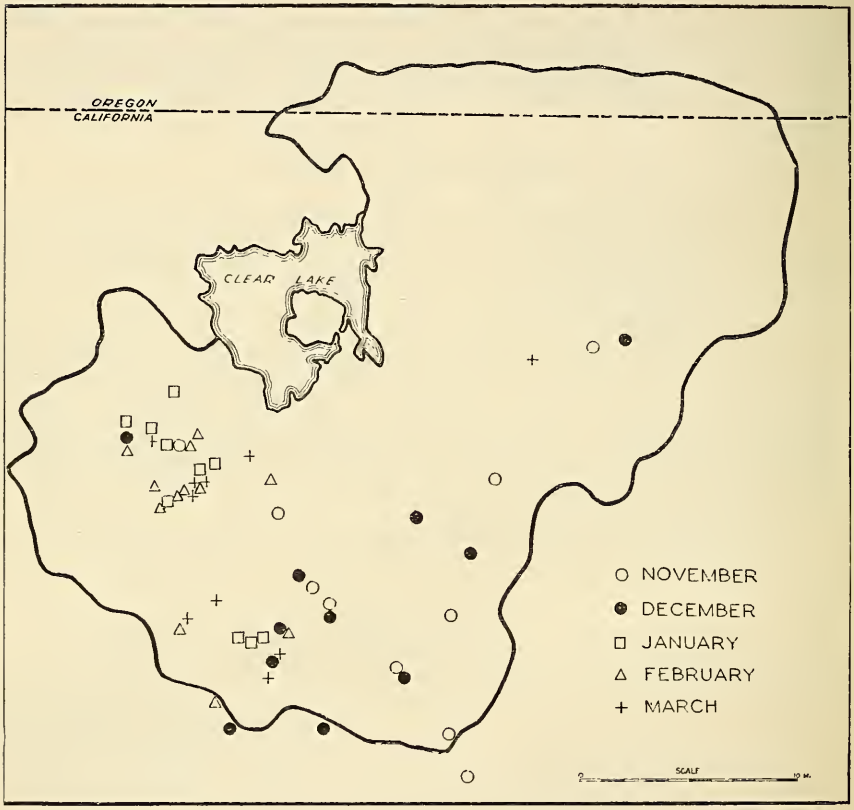

FIGURE 137. Location of deer collections

deer was initiated November 1, 1946, with 10 deer being taken each month (five at the first of each month and five the fifteenth of each month). Collections were continued in this manner through March 15, 1947. Three deer accidentally killed by automobiles were also collected. A summary by range type of the number of deer collected each month is presented in Table XVII.

TABLE XVII

Distribution of Samples by Range Types by Months—1946-47

Range type	November	December	January	February	March	Total
Badger pine	3	6	0	0	3	12
Juniper browse	3	2	0	0	1	6
Bitterbrush transition	2	2	3	2	2	11
Juniper annual grass	2	1	7	9	5	24
Totals	10	11	10	11	11	53

Field Methods. The stomachs were removed from the deer in the field and the total contents measured. After measuring the total contents, a representative sample of approximately one quart was taken, squeezed dry, and wrapped in cheese cloth, preserved in formaldehyde and brought back to the laboratory for analysis. Food volume of stomach contents averaged 4,800 cc. with extremes of 2,000 cc. and 7,000 cc.

Laboratory Methods. The preserved sample was washed out and analyzed independently by three workers. Each worker estimated the percent by volume for individual food items. The results were then compared and any discrepancies in the percentage estimates were reconciled by discussion and reexamination of the sample in question. Major food items were readily identifiable, but no effort was made to separate the various species of grasses.

Results of Analysis. The percentage by volume for major forage species is shown in Fig. 138. Table XVIII shows the same species by range types. Fig. 138 indicates general trends in the use of individual species by months or availability of species. A summary of all browse species compared with all grass and other herbs is shown in Table XIX.

TABLE XVIII

Summary of Food Plants (by Volume Percent) by Range Type

(November, 1946, Through March, 1947)

	Badger Pine	Juniper Browse	Bitterbrush Transition	Juniper annual grass	Total
Browse Species					
Sage	4.3	3.1	23.0	29.3	19.4
Bitterbrush	22.2	9.4	38.5	1.7	14.8
Juniper	4.0	6.2	18.5	8.9	9.4
Squaw Carpet	18.5	1.7	4.3	----	5.3
Mahogany	4.5	20.9	1.0	----	3.6
Lichen	1.3	0.6	1.7	----	0.7
Manzanita	0.7	----	0.2	----	0.2
Rabbit Brush	----	----	----	Trace	Trace
Grazing Species					
Dry Grass	28.8	31.6	8.3	42.5	31.2
Green Grass	8.2	0.3	0.7	5.3	4.5
Balsamorhiza	7.3	10.0	1.9	5.4	5.6
Phlox	----	15.9	1.9	3.6	3.8
Mustard	----	----	----	3.2	1.5
Buckwheat	0.2	0.3	----	----	0.1
Subtotal—Browse	55.5	41.9	87.2	39.9	53.4
Subtotal—Grazing	44.5	58.1	12.8	60.0	46.7
Number Stomachs Analyzed	12	6	11	24	53

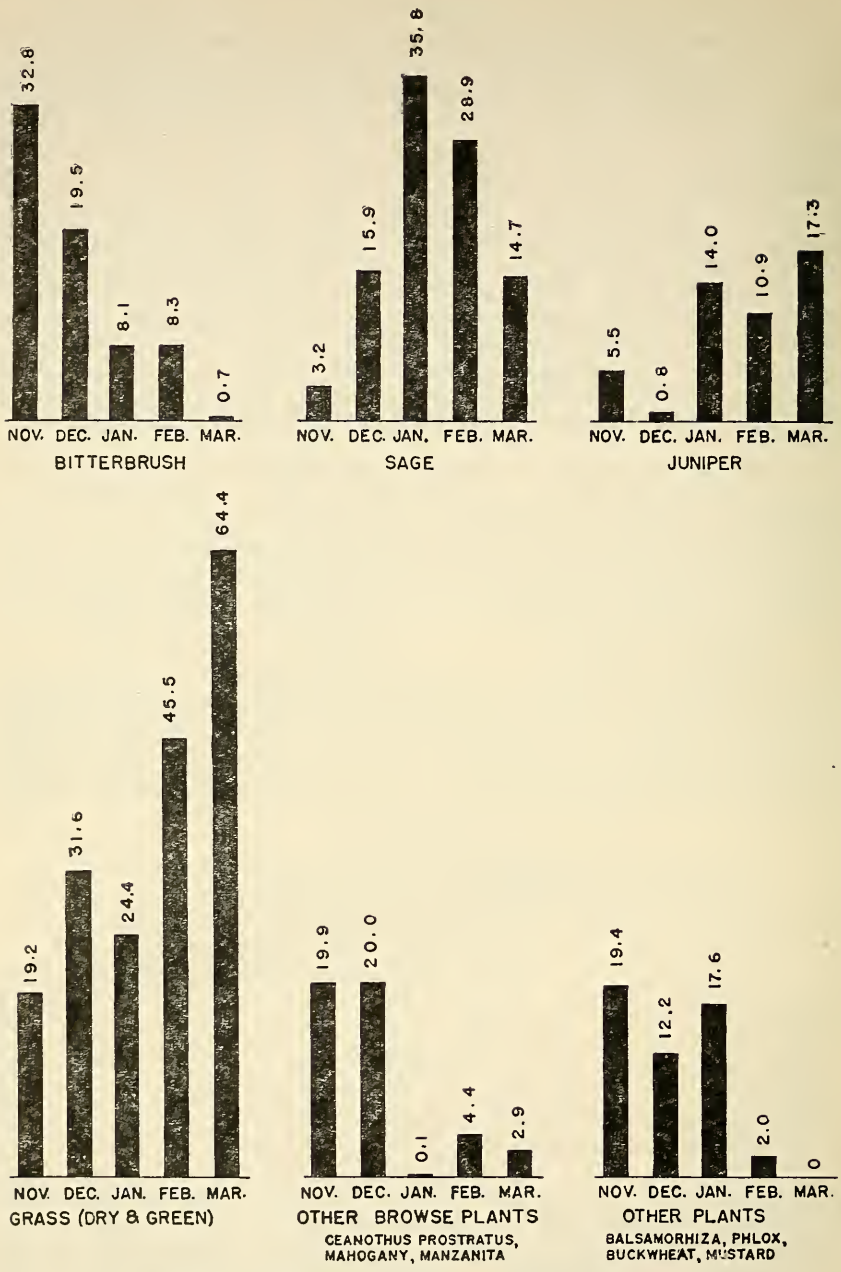

FIGURE 138. Summary of food by plant species by months

TABLE XIX

Percentage of Browse vs. Grasses and Other Herbs Taken by Months

(Derived From Fig. 138)

	November	December	January	February	March
Browse (all species)	61.3	56.1	58.0	52.6	33.6
Grasses and other herbs	38.7	43.9	42.0	47.4	64.4

Life History

The deer collected also yielded information on weights, external measurements, pregnancy records, disease and parasite data, and lactation. Certain of these data are summarized in Tables XX and XXI.

Seven deer were lactating at the time of collection: Three on November 1st, two on November 15th, and two on December 1st.

TABLE XX

Weights and Measurements of Deer

	Mean	Minimum	Maximum	Number measured
Live weight (pounds)	123.0	92.0	149.5	60
Total length (inches)	65.2	59.0	71.0	60
Hind foot length (inches)	19.0	18.0	20.0	60
Tail length (inches)	6.9	5.5	9.0	57
Ear length (from notch.) (inches)	8.1	7.25	9.0	38

Pregnancy

After January 14, 1947, pregnancy could be determined macroscopically and summary of the 1945-46 and 1946-47 records includes data on 49 females (Table XXI).

TABLE XXI

Summary of Pregnancy Data

	1945-46	1946-47	Total
Does examined	12	37	49
Number (and percent) pregnant	12 (100)	36 (97.2)	48 (98)
Number embryos	20	64	84
Number embryos per pregnant doe	1.67	1.78	1.75

Deer Survival

Figure 139 presents the populations (as computed from car strip censuses) of adults and fawns by sexes over the four years of intensive study in the Modoc National Forest. Fawns are segregated as to sex on an assumed ratio of 100:100.

As the chart indicates, there were 1,548 adult bucks and 2,538 male fawns in 1943-44, but of these only 1,440 adult bucks remained the following year, indicating a loss of 2,646 males. The following years, 1944-46,

the loss computes to 3,900 and 2,011, for a total loss for the three-year period of 8,557. It is estimated that less than 3,000 of this loss was hunter take and the remainder were cripples and natural losses.

The doe loss for the period computes to 14,433. None were taken legally in either state during the period.

In addition to the above losses, the fall count of fawns is far below the number of embryos of the preceding spring. As shown above, the doe: Embryo ratio in the spring of 1946 was 1:1.6, while the doe: Fawn ratio in the fall-winter of 1946-47 was 1:0.61, indicating a loss of one embryo or fawn per doe per year for the intervening period.

Parasites

At the time the animals were skinned they were examined for ectoparasites, which were found in 58 of the 60 deer examined. Ectoparasites were not numerous. Ticks and hippoboscid flies occurred most frequently. The ticks included at least two species of *Dermacentor* and one species of *Ixodes*. Very few fleas were found and both biting and sucking lice were present but rare.

The internal organs were removed and examined for parasites. The following were found: Tapeworm cysts (cysticercus stage—*C. tenuicollis*—of *Taenia hydatigena*) in 56; cecal worms (*Oesophagostomum venulosum*) in four; and footworms (*Wehrdikmansia cervipedis*) in 54 deer. No other parasites of significance were found.

Tapeworm cysts usually were found on the mesenteries, particularly the omentum. In a few animals the liver was infected with these cysts. A single cysticercus was found in the lung of one animal and was tentatively determined as the cyst stage of *Taenia ovis*. Fragments of the tapeworm *Monezia benedeni* were found in the intestinal tract of one deer. It could not be determined if the accompanying hemorrhage was the result of the tapeworm infection. In one deer hemorrhage was found in the abomasum (fourth stomach), but no parasites were found in conjunction with it.

Footworms were found in all feet of deer and nowhere else on the body. Thirty-eight animals had all four feet infected. No lesions attributable to these worms were evident.

One crippled doe was collected and at autopsy showed evidence of a healed fracture of the right scapula and humerus. One animal had a small tumor-like growth (about 2 cm. in diameter) attached to the inner wall of the rumen (first stomach). One deer had a small twig of juniper lodged in the lung tissue, with a small abcess forming about it. It was apparently of recent origin as there was no evidence of host reaction to wall off infection.

There is no evidence from the work of the current season covered in this report, or from the preliminary work of the previous season, that would indicate disease to be a problem in the interstate deer herd during the months under study. Even though such a large percentage of the animals were infected with tapeworm cysts and footworms, there was no evidence that the intensity of these infections caused any animal examined to be in poor condition. Although these parasites could potentially, in greater numbers, cause severe damage, it is felt that in the examination of 60 random specimens some indications of this would have shown up if the problem were present.

On the possibility of determining a correlation factor between the amount of fat in the heart and the condition of an animal, analysis of the amount of fat present in each heart was attempted. The standard techniques used for this purpose present many variables and it is felt that the data obtained do not give a reliable index. However, in the process of obtaining the data necessary for the calculations it was observed

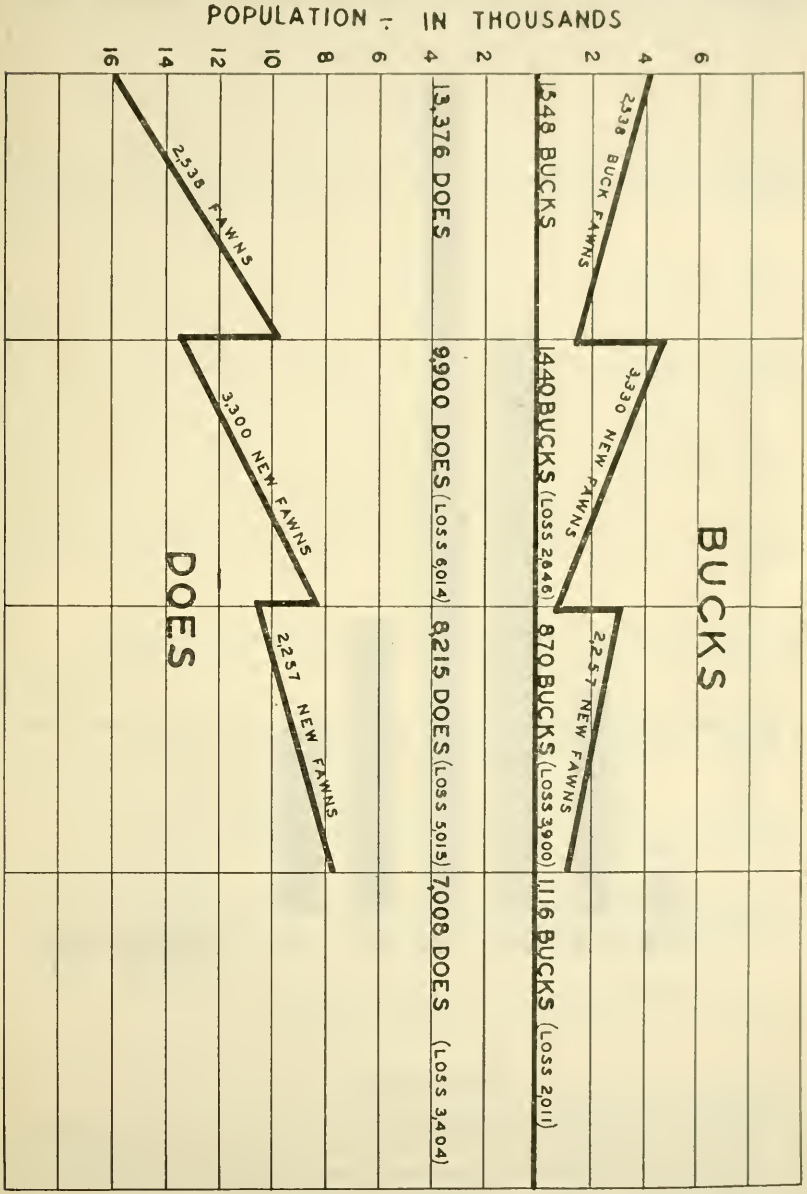

FIGURE 139. Survival of deer by sexes as indicated by herd composition and size each year. Total loss: bucks, 8,557; does, 14,433

that the percentage of heart weight to total weight indicates that the heart is roughly slightly less than one percent of the total weight of the animal (Fig. 140).

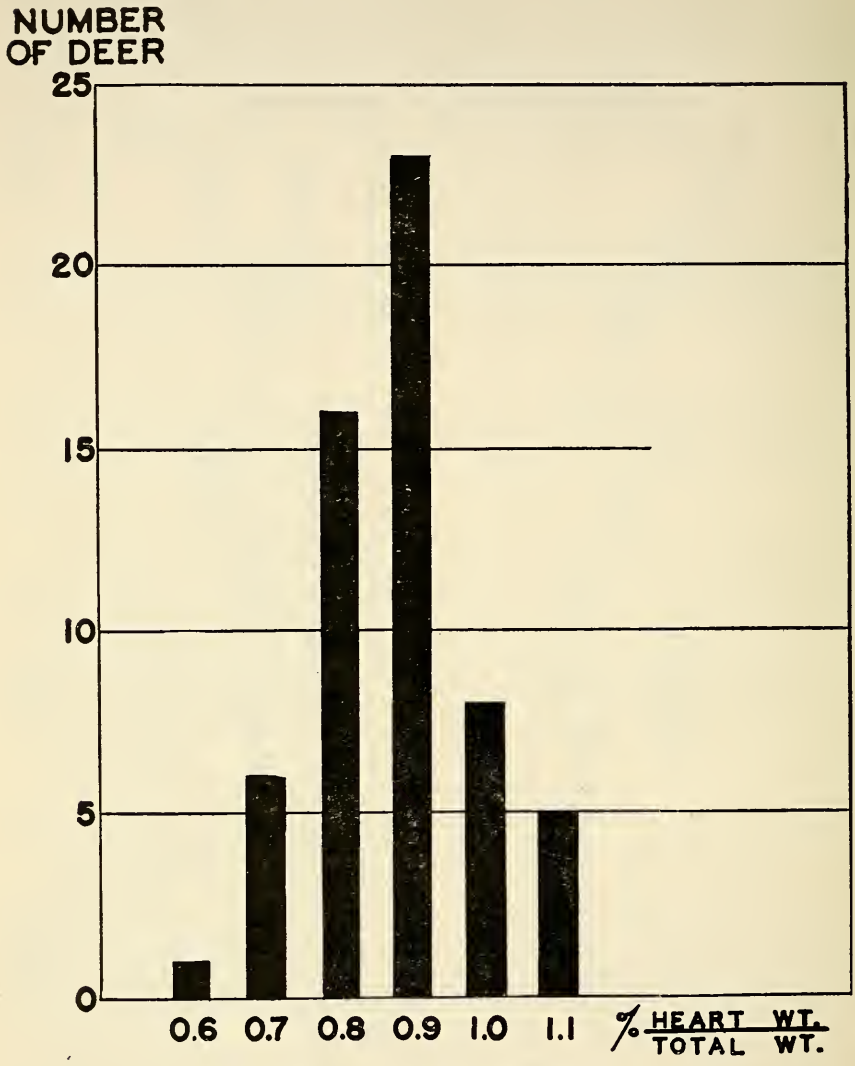

FIGURE 140. Percentage $\frac{\text{Heart wt.}}{\text{Total wt.}}$

Management

Reseeding. The range reseeding program instituted in 1944 was continued in 1946. Approximately 189 acres in Saddleblanket Flat were disked and seeded to western wheat and crested wheat grasses and dryland Ladak alfalfa. In 20 acres, bur clover was added to the mixture. The program will be continued in 1947.

Wild horse problem. "Beginning a number of years ago, a wild horse population began to build up on the Doublehead-Devil's Garden area. Attempts were made to keep the population down by the periodic removal of horses. By 1946, this population had again built up to the point at which it was becoming a serious threat. During April and May, under a closing order issued by the Secretary of Agriculture, 287 horses were removed from the range used to a large extent by the interstate deer herd. These horses used the range yearlong, consuming 3,444 horse-months of forage. This meant that some pressure and over-use was relieved on local areas and more forage became available for winter deer use." (Interstate Deer Herd Committee, 1946.)

The problem is not yet entirely eliminated, as it is estimated that approximately 100 wild horses remain on the range. With the expiration of the Secretary's closing order, trespass domestic horses again appeared on the range. Ownership of these horses is difficult to determine during the summer season since they intermingle with permitted horses and during the winter it is impossible to read brands.

Trespass. In view of the depleted condition of the range it is important that trespass livestock be reduced to a practical minimum. During the fall of 1946 effort was made to obtain as complete removal of livestock as possible. On an open and unfenced range as large as that used by the winter deer herd, small groups of cattle are sometimes missed by riders. As these were observed, permittees were notified and removal requested. In spite of all efforts, several small bunches remained on the range. Any estimate of the number of cattle that wintered on the area is purely a guess, and judging from the number seen at various times, probably does not exceed 50 head for the six months.

Summary

1. Further decrease in number of deer utilizing the winter range was indicated by census: 1944-45—18,000; 1945-46—13,600; 1946-47—12,400.

2. During the past year the percent of bucks classified increased to 9.0 percent from 6.4 percent, and the percent of bucks classified in the larger antler classes has increased.

3. Percent of fawns recorded in the herd compares favorably with other herds, in spite of the loss which occurs between conception and the following winter.

4. The four census methods—car strip counts, track counts, pellet group counts, and airplane counts obtained relatively consistent results.

5. Attempts to trap and mark deer were unsuccessful.

6. Bitterbrush utilization studies indicate a need for reduced stocking on this deer-livestock range.

7. Stomachs of 53 collected deer were analyzed. Life history information was also obtained on weights and measurements, pregnancy, and parasites.

8. Range reseeding was continued.

9. Wild horse problem still exists and some trespass livestock are still present on the range.

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FISH CASES

April, May, June, 1947

Offense	Number arrests	Fines	Jail sentences (days)
Abalone: taking from shell below high water, no license, undersized, overlimit, taking to sell commercially	271	$8,445 00	10
Angling: no license, too many hooks, closed season, failure show license, false statements to obtain a license, failure have alien license while fishing, using another's license, use of two poles, more than one line, closed area, 150 feet of dam, set line Dist. 2, destroying fish ladder, back dating license	178	2,787 00	5
Barracuda: no license	1	5 00	-
Bass: taking closed season, set line, illegal net, no license, undersized, at night, 2 rods, using sunfish as bait, more than one line, possession closed season, before sunrise, at night, using undersized as bait	230	6,447 00	4
Catfish: taking with set line, undersized, too many lines, more than one pole	15	252 50	
Chums: undersized	1	25 00	
Clams: possession undersized, overlimit, out of shell	95	2,725 00	37½
Cockles: taking overlimit, undersized, no license	22	510 00	-
Commercial: possession illegal gill net, no license, drag net, seining, closed district, set lines, failure stop allow inspection, failure make reports, no license, round haul net Dist. 19A, untagged, failure keep log	123	2,125 00	
Crabs: possession undersized	5	500 00	
Crappie: closed season, overlimit, no license	24	352 50	50
Lobster: closed season, unpunched, undersized	22	1,455 00	-
Perch: no license, closed season	2	60 00	
Pollution	18	2,200 00	-
Salmon: undersized, operating nets, taking in Dist. 12A, no boat numbers, at night in Dist. 1, possession of spear, attempt gaff, attempt snag, other than angling	26	1,305 00	-
Seals: shooting from power boat	1	25 00	-
Sturgeon: possession of	1	75 00	-
Sunfish: taking closed season, no license, overlimit	128	3,533 00	-
Trout: closed season, spearing, shooting, overlimit, untagged, possession spear 300 feet stream, set lines, too many hooks, poles, unattended, chumming with salmon eggs, possession of spear in river, false statements in obtaining license	275	7,639 50	449
Totals	1,438	$40,466 50	555

GAME CASES

April, May, June, 1947

Offense	Number arrests	Fines	Jail sentences (days)
Beaver	2	$100 00	
Coots: closed season, shooting from auto	12	265 00	25
Deer: killing spiked buck, illegal possession, closed season, at night with spotlight, taking female deer, assisting taking closed season, no tags, possession tags not issued to, possession light and gun	25	2,505 00	120
Deer meat: illegal possession, closed season, untagged	12	1,425 00	
Doves: no license, closed season	12	525 00	
Ducks: closed season, unplugged shot gun, chasing, killing with motor boat	27	1,072 50	
Frogs: closed season, overlimit	4	70 00	
Grouse: possession	1	25 00	
Geese: closed season	3	150 00	
Grey squirrel	4	50 00	
Hunting: no license, possession gun in refuge, discharging firearms in refuge, night, shooting from auto, shooting across and on highway	57	1,170 00	
Nongame birds: take with trap, possession	12	285 00	
Pheasants: closed season, taking hen, shooting from auto, use of rifle, fully protected, possession hen, no license, overlimit	30	2,650 00	
Quail: closed season	9	687 50	
Rabbits: closed season, spot light, at night	67	1,657 50	
Shore birds	3	100 00	
Antelope: closed season	1	25 00	
Totals	281	$12,762 50	145

SEIZURES OF FISH AND GAME
April, May, June, 1947

Fish:	
Abalone	1,589
Abalone, pounds	----
Barracuda	86
Barracuda, pounds	4,062
Bass	204
Bass, pounds	343
Carp	114
Catfish	20
Catfish, pounds	100
Cockles	9,573
Crappie	42
Lobster	263
Lobster, pounds	6,675
Salmon	7
Salmon, pounds	1,362
Sturgeon, pounds	10
Trout	559
Trout, pounds	2,799
Game:	
Coots	12
Deer	1
Deer meat, pounds	801
Doves	38
Ducks	119
Frogs	2
Geese	54
Nongame birds	20
Pheasants	57
Quail	19
Rabbits	123
Antelope meat, pounds	35

DIVISION OF FISH AND GAME
STATEMENT OF EXPENDITURES

For the Period July 1, 1946, to June 30, 1947 (Ninety-eighth Fiscal Year), as of July 31, 1947

Function	Salaries and wages	Operating expenses	Equipment	Total
Administration:				
Education and public information	$6,262 96	$12,072 86	$1,481 58	$19,817 40
Executive	10,650 00	7,703 98	1,159 03	19,513 01
Exhibits		504 61		504 61
Library	2,605 83	365 42	338 01	3,309 26
Office	25,539 89	115,509 95	296 83	141,346 67
Unallocated		383 75		383 75
Undistributed		-5 70		-5 70
Total Administration	$45,058 68	$136,534 87	$3,275 45	$184,869 00
Patrol and Law Enforcement:				
Airplane		$1,487 03	$3,201 87	$4,688 90
Cannery inspection	$8,647 26	25 15		8,672 41
Executive	31,646 13	5,548 37	698 45	37,892 95
Land patrol	381,217 53	149,487 72	67,446 59	598,151 84
Marine patrol	108,950 37	54,129 51	21,220 96	184,300 84
Office	44,365 66	1,890 58	1,077 12	47,333 36
Unallocated		10,168 55		10,168 55
Total Patrol and Law Enforcement	$574,826 95	$222,736 91	$93,644 99	$891,208 85
Marine Fisheries:				
C.V.W.P. and salmon study	$33,047 66	$12,439 32	$9,860 98	$55,347 96
Executive	10,520 00	1,670 27	1,394 88	13,585 15
Fish cannery auditing		6,451 01		6,451 01
Laboratory	10,815 80	3,666 89	1,499 58	15,982 27
Library	2,041 86	67 15		2,109 01
Office	12,241 60	2,085 08		14,326 68
Scientific investigation	27,853 56	3,933 10	5 50	31,792 16
Statistics	35,796 45	10,356 36	54 44	46,207 25
Unallocated		511 19		511 19
Total Marine Fisheries	$132,316 93	$41,180 37	$12,815 38	$186,312 68
Fish Conservation:				
Biological survey	$38,122 48	$11,047 28	$3,694 44	$52,864 20
Executive	16,740 00	2,127 49		18,867 49
Field supervision	27,590 00	2,344 18	802 40	30,736 58
Fish food unallocated		63,096 25		63,096 25
Fish planting		4,064 82	3,700 00	7,764 82
Fish rescue	8,652 91	2,585 44	3,009 92	14,248 27
Fish screens		3,010 15	9 82	3,019 97
Office	10,659 76	293 33	339 18	11,292 27
Operating expenses unallocated		1,358 27	298 07	1,656 34
Pollution inspection	3,320 00	105 14		3,425 14
Stream improvements	6,045 02	124 66		6,169 68
Statistical		59 29		59 29
Structural maintenance		8 32		8 32
Unallocated		11,741 23	119 89	11,861 12
Unallocated—automobile, gas, oil		3,727 47		3,727 47
Alpine Hatchery		11 88		11 88
Basin Creek	7,516 70	2,641 53	22 30	10,180 53
Benbow Dam	2,015 00	361 12		2,376 12
Black Rock Springs		336 99		336 99
Blue Lake Egg Collecting Station		98 10		98 10
Brookdale Hatchery	7,821 29	1,988 18	184 23	9,993 70
Burney Creek Hatchery	8,478 46	2,316 79	35 14	10,830 39
Cedar Creek		538 66		538 66
Central Valley Hatchery	10,343 54	3,506 79	61 17	13,911 50
Copco Egg Collecting Station		85 00	256 25	341 25
Coy Flat Hatchery	113 41	75 68		189 09
Crystal Lake Hatchery		10 69	78 39	89 08
Fall Creek Hatchery		1,018 79	9 33	1,028 12
Feather River Hatchery		2,278 52	80 43	2,358 95
Fillmore Hatchery		16,482 85	8,096 56	24,579 41

DIVISION OF FISH AND GAME
STATEMENT OF EXPENDITURES—Continued
For the Period July 1, 1946, to June 30, 1947 (Ninety-eighth Fiscal Year), as of July 31, 1947

Function	Salaries and wages	Operating expenses	Equipment	Total
Additional—				
Fall Creek Hatchery	6,605 01			
Feather River Hatchery	6,232 84			
Fillmore Hatchery	26,806 05			39,643 90
Heenan Lake Egg Collecting Station		107 20		107 20
Hot Creek Hatchery	20,627 78	39,764 59	2,161 51	62,553 88
Huntington Lake Hatchery	325 00	6 15		331 15
June Lake Egg Collecting Station	193 55			193 55
Kaweah Hatchery	7,146 31	1,660 30	12 55	8,819 16
Kern Hatchery	3,585 28	2,148 06	1,166 07	6,899 41
Kings River Hatchery	7,832 75	3,183 00	76 77	11,092 52
Klamathon Hatchery		434 43		434 43
Lake Almanor Hatchery	9,967 39	2,890 55	103 93	12,961 87
Little Walker Lake Hatchery		113 45		113 45
Mad River Egg Collecting Station	1,029 74			1,029 74
Mojave River Hatchery	1,240 00	317 36	7,727 39	9,284 75
Moorehouse Springs Hatchery		244 50	32 98	277 48
Mt. Shasta Hatchery	58,556 97	14,252 06	565 62	73,374 65
Mt. Tallac Hatchery	5,026 46	2,845 50	2,796 10	10,668 06
Mt. Whitney Hatchery	29,890 95	31,944 87	4,227 50	66,063 32
Owens Park Experimental Ponds		184 76		184 76
Prairie Creek Hatchery	7,828 53	2,217 63	202 59	10,248 75
Rush Creek Hatchery		24 20		24 20
San Lorenzo Hatchery		72 86		72 86
Sequoia Hatchery	5,794 51	1,425 98	18 99	7,239 48
Shasta River Hatchery	476 67	318 97		795 64
Snow Mountain Hatchery	1,013 54	325 72		1,339 26
Tahoe Hatchery	7,480 40	4,779 32	3,499 33	15,759 05
Tuolumne Hatchery	837 74			837 74
Whittier Hatchery	10,607 10	2,809 15	99 43	13,515 68
Yosemite Hatchery	6,614 51	1,703 76		8,318 27
Yreka Warehouse			6 66	6 66
Yuba River Hatchery	4,246 13	219 93		4,466 06
Total Fish Conservation	$377,383 78	$251,439 19	$43,494 94	$672,317 91
Game Conservation—108:				
Brawley Game Farm	$940 00	$526 60	$1,092 78	$2,559 38
Castaic Farm	2,640 00	755 52		3,395 52
Chino Farm		338 91	1,229 15	1,568 06
Elk Refuge	2,980 00	1,071 64		4,051 64
Executive	1,547 61	3,142 89	941 24	19,558 74
Fresno Game Farm	9,101 50	4,283 87	70 54	13,455 91
Game Bird District—Los Serranos	400 00			400 00
Game management	45,839 23	24,256 05	652 51	70,747 79
Grey Lodge Refuge	8,263 32	1,178 85		9,442 17
Honey Lake Refuge	8,821 41	4,183 42	409 07	13,413 90
Imperial Refuge	4,910 00	1,618 66		6,528 66
Imperial Valley Public Shooting grounds		2,204 08		2,204 08
Los Banos Refuge	5,640 00	2,045 41	76 96	7,762 37
Los Serranos Game Farm	18,914 87	11,277 68	25 33	30,217 88
Marysville Game Farm			1,119 06	1,119 06
Office	9,217 40	628 65	306 21	10,152 26
Porterville Game Farm	1,619 35	737 86	1,122 16	3,479 37
Predatory animal lion hunting	12,647 90	13,293 09	51 87	25,992 86
Predatory animal trapping	74,481 52	26,986 87	5,107 97	106,576 36
Predatory birds		372 00		372 00
Redding Game Farm	5,128 57	1,965 47	1,052 04	8,146 08
Research	15,379 03	5,418 08	1,640 23	22,437 34
Sacramento Game Farm	5,050 98	1,665 08		6,716 06
Statistics		1,527 37		1,527 37
Suisun Refuge	4,525 07	1,032 07	24 81	5,581 95
Tehama Winter Deer Range			7 69	7 69
Unallocated—automobile, gas, oil		4,114 13		4,114 13
Ukiah Game Farm		277 63		277 63
Valley Center Game Farm	1,910 00	809 62		2,719 62
Valley Center Farm		88 44		88 44
Visalia Game Farm	310 00			310 00
Willows Game Farm	3,181 28	1,517 60		4,698 88
Winter feeding and salting of game		4 55		4 55
Yountville Boarding House	2,079 02	5,093 54		7,172 56
Yountville Game Farm	34,384 40	18,344 79	267 48	52,996 67
Total Game Conservation	$293,839 46	$140,760 42	$15,197 10	$449,796 98

DIVISION OF FISH AND GAME
STATEMENT OF EXPENDITURES—Continued
For the Period July 1, 1946, to June 30, 1947 (Ninety-eighth Fiscal Year), as of July 31, 1947

Function	Salaries and wages	Operating expenses	Equipment	Total
Licenses—111:				
Executive	$9,180 00	$1,629 93		$10,809 93
License distribution	23,770 95	194,138 17	$1,046 90	218,956 02
Office	2,537 90	1,722 35	6 02	4,266 27
Unallocated—automobile, gas, oil		169 98		169 98
Total licenses	$35,488 85	$197,660 43	$1,052 92	$234,202 20
Conservation of Fish Screens and Stream Improvements				
Fish screens		$3,254 85		$3,254 85
Total Fish and Game Support, 98th Fiscal Year				$2,621,962 47
Less estimated maintenance deductions				13,312 92
Net total Fish and Game Support, 98th fiscal year				$2,608,649 55
Total Operating Expenditures, 98th fiscal year				$2,608,649 55
Additions and Betterments:				
Land—				
Appraisal of Welch Tract in Colusa County			$323 69	
Acquisition, establishment and maintenance of fish hatchery (Ch. 1439-45), Los Angeles County			7,214 95	
San Bernardino County			19,271 97	
Improvements (Ch. 644-45)—				
Alteration and modernization of Hatchery buildings			7,902 98	
Alterations to Botanical Gardens Building—Game Conservation Research Laboratory			3,050 29	
Brooder Houses and Pens (Ch. 106-46)—				
Sacramento Game Farm			132 41	
Brooder Houses and Pens (Ch. 644-45—				
Yountville Game Farm			4,166 82	
Brookdale Hatchery propane installation			1,128 00	
Central Valley Hatchery			682 78	
Coast Counties Quail Project Warehouse			1,363 17	
Construction of rearing ponds—all hatcheries			122 84	
Construction of salmon traps in Central Valleys and Trinity River water sheds			60 00	
Construction and equipment of workman shop and warehouse at Yreka			2,143 05	
Cattle guard fence, Crystal Lake Hatchery			11,000 00	
Crystal Lake Hatchery			116,428 59	
Drilling of well, Kern Hatchery			461 79	
Engineering project			10,000 00	
Experimental electrical and mechanical fish screens			8,455 03	
Fish Ladders and Dams—				
Clough Dam on Mill Creek			8,000 00	
Woodbridge Dam			65,400 00	
Game Conservation—				
Game farms—miscellaneous improvements			4,009 74	
Honey Lake Refuge			522 61	
Imperial County public shooting grounds			1,633 83	
Improvement of Game Farm—				
Brawley			6,183 30	
Chico			448 11	
Marysville			4,306 72	
Portersville			5,737 28	
Improvements to Tule Lake and Madeline Reservoirs			4,114 72	
Kern Hatchery			172 56	
Mt. Tallac Hatchery			63 88	
Mt. Whitney—Hatchery wire installations			850 00	
New construction—Tahoe Hatchery			3,705 50	
Redding Game Farm—Cottage and garage			5,175 00	
Redding Warehouse			358 05	

DIVISION OF FISH AND GAME
STATEMENT OF EXPENDITURES—Continued

For the Period July 1, 1946, to June 30, 1947 (Ninety-eighth Fiscal Year), as of July 31, 1947

Function	Salaries and wages	Operating expenses	Equipment	Total
Additions and Betterments:—Continued				
Remodel Living Quarters—				
Fresno Game Farm			501 23	
Sacramento Game Farm			52 10	
Replacement of pipe lines—all hatcheries			794 17	
Tahoe Hatchery improvements			194 24	
Tehama winter range			5,385 00	
Terminal Island Laboratory			4,500 00	
Terminal Island parking area paving			760 00	
Tuna fisheries research facilities			640 63	
Total Additions and Betterments				$317,417 03
Specific Item, Cooperation with Federal Government				
Pittman-Robertson Act				
All projects	$36,688 68		$107,632 85	$144,321 53
Less indicated abatement from Federal Government, pro rata share Pittman-Robertson Act				30,937 46
Net Total, Pittman-Robertson Act				$113,384 07
Contra to State Employees Retirement Fund				108,358 97
Grand Total Fish and Game Preservation Fund, 98th fiscal year				$3,147,809 62

DIVISION OF FISH AND GAME
STATEMENT OF REVENUES

For the Period July 1, 1946, to June 30, 1947 (Ninety-eighth Fiscal Year)

	Detail	Total
Revenue for Fish and Game Preservation Fund:		
License Revenue:		
1947 series—		
Angling:		
Citizen	$898,806 00	
Nonresident	11,367 00	
Alien	6,015 00	
Duplicate	356 00	
		$916,544 00
Hunting—Citizen	$20 00	20 00
Fish packer and shellfish dealer—Citizen	430 00	430 00
Deer tags	6 00	6 00
Fish tags	3,606 71	3,606 71
Game tags	126 21	126 21
Market fisherman	78,190 00	78,190 00
Fish importer	65 00	65 00
Fish party boat permits	529 00	529 00
Fish breeder	400 00	400 00
Game breeder	2,600 00	2,600 00
Kelp license	40 00	40 00
Game management area licenses	80 00	80 00
Total 1947 series		$1,002,636 92
1946 series—		
Angling:		
Citizen	$773,065 00	
Nonresident	18,642 00	
Alien	6,520 00	
Duplicate	3,294 50	
		$801,521 50
Archery—Hunting citizen	$1,902 00	
Hunting—Citizen	873,306 00	
Hunting—Junior	41,317 00	
Archery—Hunting nonresident	145 00	
Hunting—Nonresident	41,670 00	
Hunting—Declarant alien	2,370 00	
Hunting—Alien	3,225 00	
Hunting—Duplicate	2,305 00	
		$966,240 00
Commercial Hunting Club	$725 00	725 00
Commercial hunting club operator	245 00	245 00
Trapping:		
Citizen	1,961 00	
Alien	28 00	
		$1,989 00
Fish packer and shellfish dealer:		
Citizen	$1,790 00	
Alien	20 00	
		$1,810 00
Archery—Deer tags	$604 00	
Deer tags	282,053 00	
		$282,657 00
Fish tags	$2,569 89	2,569 89
Game tags	369 51	369 51
Market fishermen	50,090 00	50,090 00
Fish importers	10 00	10 00
Fish party boat permits	153 00	153 00
Fish breeder	75 00	75 00
Game breeder	190 00	190 00
Kelp license	10 00	10 00
Game management area licenses	10 00	10 00
Game management area tags	53 73	53 73
Deer meat agents—Locker permits	11,285 00	11,285 00
Deer meat agents—Wardens	596 00	596 00
Total 1946 series		$2,120,599 63

DIVISION OF FISH AND GAME
STATEMENT OF REVENUES—Continued
For the Period July 1, 1946, to June 30, 1947 (Ninety-eighth Fiscal Year)

1945 series—		
Angling:		
Citizen	$5,028 00	
Nonresident—Debit	—3 00	
Duplicate	3 50	
Hunting:		
Citizen	$17,454 00	
Junior	1,198 00	
Nonresident	120 00	
Declarant alien	20 00	
Duplicate	68 50	
Deer tags	23 00	
Fish tags	83 01	
Game breeder	90 00	
Kelp license—Debit	—70 00	
Game management area licenses—Debit	—20 00	
Deer meat agents—Locker permits	12 50	
Total 1945 series		$24,007 51
Other Revenue—		
Court fines	$110,058 64	
Lease of kelp beds	52 80	
Fish packers tax	218,534 03	
Kelp tax	3,154 16	
Salmon tax	43,618 85	
Miscellaneous revenue	32,333 56	
Interest on surplus money investment fund	1,429 37	
Total other revenue		$409,181 41
Grand total Fish and Game Preservation Fund		$3,556,425 47

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NOTICE TO DUCK HUNTERS

The United States Fish and Wildlife Service is again asking the duck hunters to cooperate during the present hunting season in securing data which will be of help in working out fair regulations. The hunter is requested to keep a tally of the birds he bags, cripples or observes this fall and, at the end of the season, send a complete score card to the United States Fish and Wildlife Service, Chicago 54, Ill. Readers of *California Fish and Game* are urged to cooperate in this program. Below is an example of the type of information desired.

Scorecard

How many, what kinds of ducks, geese bagged	How many cripples lost	Compared with last year waterfowl numbers were		
		More	Less	Same

Shooting Grounds (Check One)

Public ☐ Commercial ☐ Private ☐

Where you hunted_____ How many days_____
(State) (County)

Comments:

Date_____ Name_____

Address_____